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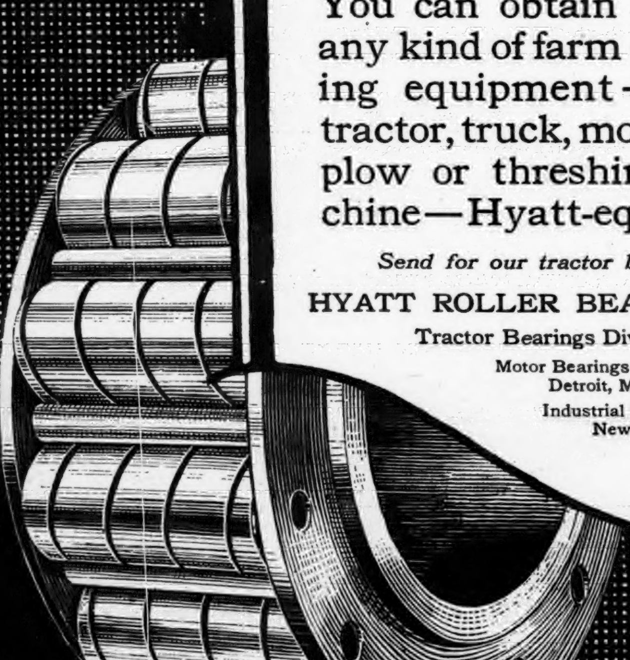

AGRICULTURAL ENGINEERING

Volume 2 APRIL, 1921 Number 4

Costs System for Farm Motor Trucks

By E. W. Lehmann

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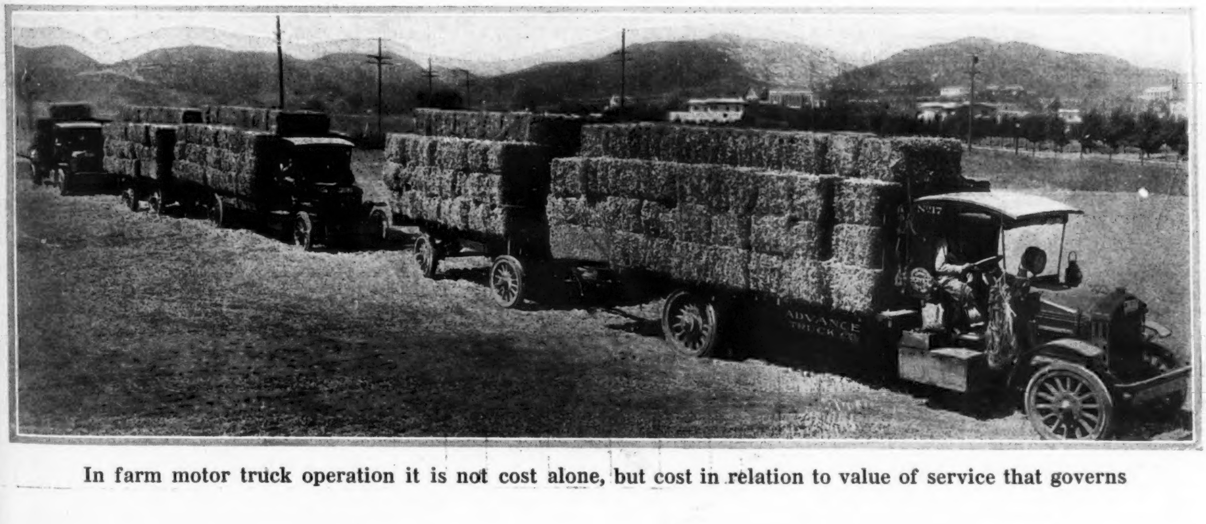
"I BELIEVE that a truck will do the job all right, and I like it, but what will it cost me after I get it?" This is a question that is being asked by the farmer about the machinery he buys. It is not only true as to his machinery and equipment but also of the new methods and ideas as applied to his farm business. Overzealous salesmen no doubt take advantage of many farmers who will accept statements of costs without thoroughly analyzing them, and few farmers keep records to check up their costs of production. Practically all the data now available on the cost of operation of farm motor trucks are based on questionnaires. While such data are of value they are not as reliable as that obtained from accurately kept cost records. While the real purpose of the motor truck cost system for the farmer is to show what work the truck is doing and the costs, there are a great many other features of equal importance. By a comparison of costs of doing a particular job under similar conditions the possibilities of economy as well as causes of wastes will be brought to light. It will no doubt be found that certain types of hauling will best be handled by teams. Some practical dairymen have found that milk routes are best taken care of with wagon and team. There are certain classes of hauling about the farm for which the farmer would no doubt find it expensive and impractical to use a truck; however, some farmers are using this expensive machine for all the minor jobs of hauling about their farms.

The carefully kept record will bring to light the common truck troubles and the causes, and provide data on the performance of the tires and other parts of the equipment which would be of equal value to truck manufacturers and farmers. Records would indicate the part of the truck that requires the most attention to get best service. The fact that the farmer does not have a first-class mechanic to take care of his machine makes a record of even greater value to him than to the city operator. It shows where troubles were encountered and what adjustments were made, when the fresh oil was added to the crankcase, and other details that one needs to know to give the machine first-class care to get the best service.

Complete cost information will make it possible for the farmer who would do hauling for his neighbor to make a fair charge without loss to himself. In hauling in cities where accurate records have been kept it has been found that the cost of fuel, oil, and tires is less than one-fourth the total expense. I do not doubt that many farmers consider these items as representing the principal expense in operating a truck, when in fact they are a smaller part of the total costs in farm hauling than in city hauling because the interest on the investment has to be distributed over a fewer number of days' service and the mileage depreciation is greater, due to less mileage, poorer road conditions and less experienced drivers.

It is only recently that the farmer has counted his labor of value, and many of them still overlook this item in cost operation. It is also true that when a truck or other machine is bought by a farmer the price is usually forgotten as far as the interest on the investment and the depreciation is concerned. These items are entirely overlooked and not considered as a part of the hauling costs. With the advent on the farm of high-priced machinery, such as the tractor and the truck, requiring a higher type of labor, the need of efficient use of this machinery and of an accurate knowledge of its costs is essential.

The comparison of costs by farmers will encourage them to practice greater fuel economy. It will indicate the kind



In farm motor truck operation it is not cost alone, but cost in relation to value of service that governs

of truck, the type of equipment and kind of tires that give best service for particular conditions.

I believe that keeping a record of the service obtained from a truck will tend to discourage overloading which is not only detrimental to the truck and the farmers' business, but also to the truck industry. It will tend toward proper legislation in regard to truck license which should be based on actual loading rather than truck rating.

Whether the farmer should adopt the truck as a means of solving his hauling problem should depend on whether better results can be obtained with it than with wagon and teams. Records will show results. Cost is not the only factor, however; the possibility of getting the produce to market more quickly and in better condition might determine its use. The fact that most trucks have sufficient capacity and speed to do the work of several wagons and teams, and the fact that the average farmer has only enough hauling to keep a truck busy relatively only a few days in the year may make it pay him to use teams for general hauling and hire a professional hauler during the rush seasons.

There are a great many different accounting systems being used by commercial haulers. Probably the one most commonly used, and of least value, is a scrap of paper on which only a rough estimate of cost is made. However, two satisfactory systems have been developed and are being used by the owners of fleets of trucks. They are the "National Standard Cost System" worked out by the Truck Owners Conference of Chicago and a system worked out by "Commercial Vehicle," New York City. For the average farmer neither of these systems is satisfactory. The average farmer's hauling is not a daily task. He has a job to do, however, and when the truck is adopted as the means of doing the job he should have some sort of a cost record system that would not only give him the costs when summarized, but also the quantity of different products hauled, the road conditions, the troubles encountered, adjustments made, fuel used and other facts that would improve his truck service. It must be simple to use, a system that he can analyze as easily as he could analyze the record of the use of a team and the yearly expense involved.

It was with this in mind that I have worked up a tentative operating cost record, keeping in mind the fundamental facts that must be considered in any system. These are daily operating charges, maintenance charge and fixed charges, and in addition a place is provided to record the road conditions, troubles encountered, adjustments made, etc. It will be noted that the operating and maintenance charges are taken care of on the one record sheet.

The summary sheet would include the fixed charges, such as the interest on the investment, the license, and insurance, also the charge for shelter and depreciation which would be more or less fixed. The summary sheet should also contain an analysis of the daily operating record, including the facts the owner is interested in finding out about. Form No. 2 is suggestive of some of the things that can be determined from the record.

In this discussion I have considered only the farm truck, it being about the latest machine adopted by farmers, and every indication points to the fact that thousands of motor trucks will be bought during the next few years. Farmers are buying high-priced trucks without definitely analyzing their hauling needs and what it really costs to own and operate one. While the problem of working this out might be really a problem in farm management, it is also a problem in engineering efficiency, and every agricultural engineer interested in the farm machinery field should get behind it with the idea of developing a standard cost system for the farmer. What has been said in regard to the truck will apply equally to the tractor and other machines. When we have determined accurately the cost of farm machinery operation, a big step forward will have been made in providing a basis for determining with a fair degree of accuracy the cost of all farm production.

TRUCK OPERATING COST RECORD*
FORM NO. 2

Name of truck ....
Owned by ....

INVESTMENT

1. Cost of truck ....
2. Cost of bodies and racks ....
3. Cost of special equipment, speedometer, etc. ....
4. Total truck investment ....
5. Present value of truck ....

FIXED CHARGES

6. Insurance cost ....
7. License and taxes cost ....
8. Charge for truck shelter ....
9. Interest on investment ....
10. Depreciation ....
11. Total fixed charge ....

SUMMARY OF OPERATING AND COST RECORD

12. No. days truck was operated ....
13. Total hours operated ....
14. Miles traveled ....
15. Amount hauled: Grain ....
Cattle.............. Hogs............ Feed.............
16. Total number of loads ....
17. Days laid up for repairs ....
18. Total fuel used ....
19. Total oil used ....
20. Total grease used ....
21. Cost of oil and grease ....
22. Cost of fuel ....
23. Cost of repairs ....
24. Cost of overhauling ....
25. Total labor costs ....
26. Total costs ....

AVERAGES

27. Miles per gallon of fuel ....
28. Cost per mile ....
29. Cost per hour ....
30. Length of haul ....
31. Cost per load ....
32. Cost per ton mile ....

*Prepared by "Successful Farming," Des Moines, Iowa, as special service to its readers.

FORM No. 1 TRUCK OPERATING COST RECORD*

FOR MONTH OF________ NAME________ ADDRESS________

Date	Time care of Truck	No. of Loads	Kind of Load	Load in Lbs.	Distance Traveled	Time		Road Conditions				Truck Troubles	Adjustment made	Nature of Repairs	Time Truck Laid Up For Repair	Cost of Repair	Time Lost by Driver	Tire Cost	Fuel		Oil & Grease		Driven By	Drivers Cost	Helpers Cost
						Running	Total	Excellent	Good	Poor	Bad								Gals.	Cost	Pts. or Lbs.	Cost			

*Prepared by "Successful Farming" Des Moines, Iowa, as a special service to its readers.

Farmstead Arrangement

By J. T. Copeland

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IT SHALL be the purpose of this paper to indicate the general need and some of the underlying, fundamental principles of farmstead arrangement.

In farming, due to the slow and oftentimes small returns on the investment, there has not been as great an evolution as is found in other occupations or enterprises. In fact, it may be truthfully said that the farmer is slow in accepting any change or improvement—he must first see that it pays.

Improved farmstead arrangement is progressing very slowly—too slowly when analyzed according to business standards. Commercial enterprises have long since profited by the employment of efficiency engineers, who have systematized operations cutting down time, distance, and space. They have effected an economic revolution in production, and competitors have been forced to improve methods or to go out of business.

In a similar capacity the agricultural engineers will serve the field of agriculture not in farmstead arrangement alone, but also in the scientific and systematized study and investment in the farm, its equipment, operation and arrangement.

Too many landowners operate their holdings in a temporary way. They do not plan to improve or develop the reputation of the farm and its products. Many are hoping that somehow business will pick up, that they will suddenly, over night, net a preponderous gain, move to town and retire. Some seem to think that the method of the father proved successful, so why change; while others have seemingly given up hope, feeling that the forefathers gleaned all the good of the land, so what's the use. There is a great need of an enterprising business spirit in our farming industry.

The South constitutes one of the greatest possible fields of improvement. With the changing from the single crop of cotton, peanuts or tobacco to diversification and livestock, the old system and arrangement is no longer adequate. Plantations were planned to scatter labor and tenants; the commissary was the chief center. These are gradually giving way to organized arrangement and division of fields, crops, labor and equipment around a common business center, the manager's or owner's home.

There is still great need that farmers and planters guard against permitting a crop, or a shed, erected for a temporary purpose becoming the center about which future buildings gather for permanency. There should be a well thought out plan adapted to the future need and purpose, and this plan should be remembered in making any change or improvement whether it be temporary or permanent.

By the way of comparison of the arrangement of a farm recently rearranged the following information may prove surprising:

The original farm consisted of four hundred acres of Mississippi prairie land, the principal crop of which was cotton. The owner of this farm formerly lived a mile away and operated the farm with five negro tenants. The present owner has built a home on the farm and is following dairying and diversified cropping with four tenants.

The crops and acreage were planned to give balance to labor, uniformity in size and shape of fields that power farming might be inaugurated, with cotton, dairy products, and hogs representing the cash income.

Paper presented at the Southern Section meeting of the American Society of Agricultural Engineers at Lexington, Kentucky, February 14 to 16, 1921.

CROP ACREAGE

Crop	As Formerly Planned	As Rearranged
Cotton	12 fields, 90 acres	1 field, 50 acres
Corn	4 fields, 23 acres	1 field, 50 acres
Alfalfa	1 field, 10 acres	1 field, 50 acres
Pasture	3 fields, 23 acres	1 field, 80 acres
Ensilage, oats, forage crops	....	3 fields, 50 acres
Lots, lawn, gardens	10 acres	20 acres
Wild hay (Johnson grass)	144 acres	....
Uncleared	100 acres	100 acres
Fence	3 fields, 23 acres (8% fenced)	9 fields, 400 acres (100% fenced)

The outstanding features were, first, the reclamation of soil by drainage and terracing and of pastures by well-located fences, and, second, the saving of time and labor through standardizing and increasing the size of fields reducing the amount of land in small patches and the amount of turning in the same.

In considering fences with the former arrangement, only eight per cent of the farm could be pastured until all crops had been harvested. When rearranged with only seven and one-half per cent of additional fence, the gleanings of all crops could be pastured with highest profit directly following the harvesting of the crop.

In changing the size, shape and contour of the fields, the amount of turning was reduced on an average of seventy-five per cent per field. This was effected by enlarging the fields and by reducing the "point" or "turn" rows as produced in former effort of carrying off the surface water via rows instead of via terraces.

In a plan for the farm and home natural beauty, system and convenience should be prime consideration, but profit should be the gauge of measure.

The proposed site should have all the natural beauty that graceful contour, streams or lakes and trees may afford. Scenery for a home setting may greatly contribute to its pleasure and comfort and will increase the commercial value of the farm when put upon the market.

Although beauty should be the first thought in selecting home premises, the next should be that of sanitation. The soil surface and soil water should be readily drained off. The contour and lay of the land should offer effective air drainage, that there may be cool refreshing breezes in summer, yet protection from cold blasts in winter. The general path of wind should carry no offensive odors of fields or barns to make home living less agreeable.

The number of buildings and the kinds of buildings to be arranged in the building site are determined by the type of farming. The type of farming is influenced by the soil and the community practice. The site, generally, should be located as near the center of the farm as the agreeable natural features, already mentioned, will permit. When located near the center of the farm, time and travel of labor to outlying fields are minimized. However, in dairying or other systems of farming where access to the highway is desirable, it may

be more economical to locate nearer the road if possible.

Generally, the farm home should be removed at least one hundred and fifty feet from the road, although the size of the farm or plantation and the natural elements may vary the practice.

The dwelling should be the foremost building with barns, sheds and lots lying after and located according to the natural adaptation. The gardens and orchards should be laid out and located in the direction from whence comes the predominating summer winds. These should be located giving choice soil and contour to the garden which should be adequately fenced against chickens. The orchard may be used as the poultry yard or as sheep lot with the proposed house or cot located for convenience of access, yet sufficiently removed to prevent noise and odor.

The remaining buildings and barns should then be located about a common court and should occupy sites adapted to their use and the natural features. This court should not be for the purpose of horse, dairy, hog or implement lot, but is rather an enclosure for handling anything that may require its space. The court should be as small as convenient, but should be reduced to prevent general use of either livestock or equipment.

With due consideration to fields and contour, the stock lots and barns should be located to give access to pastures and fields, this being wholly dependent upon the character of soil and the farm. Special attention should be given to drainage and the direction of the wind to further sanitation and to minimize fire danger. As an added factor of safety, it is desirable for the owner or supervisor to locate his bed chamber overlooking this court with the view unobstructed by tall trees and buildings.

It should be remembered that all animals need shade and shelter, that sheep and poultry do not thrive on damp soils, that hogs require forage and fresh water, that cattle need winter feed and protection with herd lots convenient to pastures and adequate water supply and that horses and mules are benefited by a lot or pasture for rest and freedom from consistent work and stable. Special attention should be given to methods of preventing spread of disease or infection. There should be dipping vats and pans to prevent contamination of stock water, and surface water from one pen or lot should not overflow the neighboring lot.

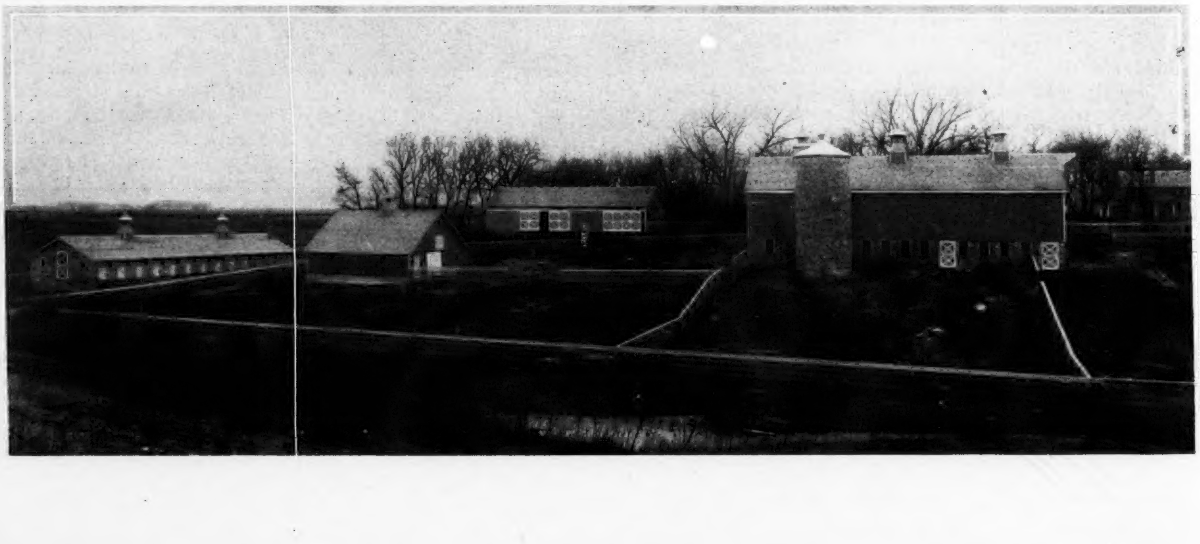
Fields should approach the form of a square with sides as nearly parallel as can be arranged. For convenience in use of power machinery, fields of at least forty acres are most advantageous. Land with more than fifteen feet of fall in one hundred horizontal feet should be cleared for cultivation, but rather it should be used for permanent pastures. Soils that have a tendency to wash should be terraced according to the best practices of the section. Wet and water-clogged soils should be drained, preferably with drainage tile laid to an engineer's grade. Particular care should be given to keeping tile outlets and open ditches free from obstructions. With the desirable land tiled and terraced it becomes an easy matter to throw irregular field outlines into pasture and woodlots. The permanent pasture should afford a ready entrance to all fields and where convenient should contain good field roads to the central building, etc.

Farm House Planning

THE average farm house shows little evidence of thought expended in its planning. There are thousands of farms on which the stock is better housed than is the farmer's family, and the farmer is better equipped for his work than is his wife. This may be good economy in the case of a young man just starting out, for his dumb beasts will not do well unless properly cared for, nor can he get the best from his fields without proper tools, while he and his wife can put up for a time with a lack of facilities in the house and with unattractive surroundings, for they are encouraged by the hope of better things to come.

If in the beginning he has not the capital for a suitable dwelling, let him build temporary quarters or so plan his house that a portion of it may be built as a nucleus of the future home and then add to it as he is able; but always let him have in mind the ultimate possession of a real home, one in which the comforts and conveniences are such that his wife will not break down in early middle age from drudgery and dreariness of outlook; one which will make life on the farm so attractive to his children that when the time comes they will be able to choose between farm and city solely on the basis of their inclination for some particular calling in life.

The farm home should be just as much a social investment as is that of the city dweller who builds his house not so much with the expectation of realizing on it, should it be necessary to sell, as to provide for himself and his family a home which shall be a pleasure to the mind and the eye, with all the conveniences and comforts. When the time comes to sell the farmer may not get all his money back, but with an attractive house on the place he will get more money for his land and his other buildings than he would without it. When he buys an automobile he does not expect to sell it or turn it in for the same amount; he charges off depreciation due to use, but in the meantime it probably has earned money for him; at least, it will have given him much pleasure. So with his house; it is an investment, the returns on which can not be measured in dollars and cents, but there is no doubt in the world that it is a paying one.



What A Four Year Course in Agricultural Engineering Should Include

By E. R. Gross

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I HAVE been interested in agricultural engineering work as a degree course for nine years or longer. This bit of personal history is offered purely as an excuse for attempting a discussion on a matter as broad as the subject in hand. Many and varied definitions have been given to this new profession of agricultural engineering. I say new because it is not yet old. Many of our state agricultural colleges now have departments of instruction and extension, variously named agricultural engineering, farm mechanics, rural engineering, farm engineering, etc., and many are the disciples of this master, but few there are who give the degree of bachelor of science in agricultural engineering. To my knowledge there are but six colleges offering a degree course in agricultural engineering, namely, Nebraska, Iowa, Kansas, Oklahoma, Missouri, and Mississippi.

That the work is in great favor is hardly questioned by those who know its scope, understand its application, and are competent to judge. As to where this new plant should grow and who should be its guardian angel there is some doubt. This is evidenced by the numerous names under which the work is conducted in our colleges, also by the variety of departments or divisions in which the work is done. For instance, we have first the big question: Is agricultural engineering an engineering or an agricultural course, or is it to be supervised by both of these colleges? These three conditions now exist: The department of agricultural engineering is under the joint supervision of the engineering and agricultural college faculties in some schools, under engineering in some, and under agriculture in others. A study of the 1920 catalogs of the six colleges mentioned above shows the degree course in agricultural engineering under the engineering division in three schools, joint supervision in two, and under agriculture in one. Mississippi is now under agriculture but will be in the engineering college in 1921-22.

The subject is so very broad and the answer so obviously not yet worked out that one would be tempted to answer it by the impossible. One could then say an agricultural engineer should be all that an agriculturist is, yet be an engineer. This leads us directly to the point. The answer given would require six to eight years college work. Yet the question implies that we are to make the agricultural engineer in four years. We must then after all begin with our existing three conditions which I will discuss in this way:

1. We might take the basic two years of agriculture (freshman and sophomore) and build to this an agricultural engineering schedule for junior and senior years. This will produce what I should call an agriculturist who has specialized or majored in agricultural engineering. He is, no doubt, a very valuable man, and we should have many of them. Furthermore, we do have them as is shown by a study of the curricula of the colleges.

2. We might devise a course, which begins in the freshman year, and lay out studies especially suited to the end of producing an agricultural engineer. This is also done. The disadvantage is that the student must select the course immediately upon entering college, for his course is different from either the agricultural man or the engineer.

Paper presented at the Southern Section meeting of the American Society of Agricultural Engineers held at Lexington, Kentucky, February 14 to 16, 1921.

3. We might take the basic course of the engineer and in the junior and senior year build an agricultural engineer. This is done and has the disadvantage of crowding all the agricultural training into the last two years. The graduate would be even heavier in engineering than is the first case in agriculture.

The solution of the problem lies in the future. Discussion can do no harm, it may do good. The success of men who graduate under these conditions will do most to work out the final four-year course in agricultural engineering.

At this point it seems wise to consider what seems to be the trend of the development. Historically, no doubt, agricultural engineering grew out of the engineer, who going out to meet farm conditions found his stock of information lacking in the essential understanding of agriculture, or the farm and farming conditions. It was necessary to bring engineering technique to the aid of farmers, as they need more and more mechanical equipment, not only tractors, engines and farm implements, but water, light and heat. This engineer could not speak the language of the farmer, hence he failed. At the same time, the agriculturist was also trying to hand the farmer the information needed, but he lacking the mechanical turn failed also. Result: The engineer with his usual resourcefulness absorbed by the agricultural touch went again and made good with Mr. Farmer. The need for the agricultural engineer was established. Work developed in the college, but since it was agricultural in its ultimate usefulness, it grew up in agriculture. Then came the need for a degree course, which has developed as above stated under three modes of supervision.

Now it seems that an idea is very popular at this time, which is specialization. But specialization cannot be without foundation. We see the college course laid out with freshman and sophomore years as basic years. The engineer takes two basic years, then specializes as civil, electrical, mechanical, chemical, or mining engineer. The agriculturist takes, also, two basic years then becomes an animal husbandman, dairyman, agronomist, horticulturist, or entomologist. What then of the agricultural engineer? He has a place in both, or he must be a hybrid. Still we have our three conditions. We may have an agricultural engineer in the agricultural college, in the engineering college, or as a joint product.

If we grant that specialization is paramount and that we should have a basic course which the student may take before selecting his major, then we should by all means allow our young farmer a chance to select agricultural engineering. Put in a group, if you please, equal to animal husbandry, dairying, agronomy, etc. This is good. Now in engineering we also have a basic two years, then let the student select from civil, mechanical, electrical, agricultural, mining engineering, etc. This will take care of the situation very nicely. Of these two men who specialize in agricultural engineering, the engineer is the professional man. Few will question this. He has the technical training needed. He is really fitted to give professional advice though he might not be able quite as well to manage a plantation.

Two difficulties arise. We will suggest their removal as follows. There is an ambiguity in the use of agricultural engineering in both schools. This may be overcome by refrain-

ing from the term engineer in other than the engineering college. We might then select "farm mechanic" as a very good name for this group in the agricultural college. This has already gained some favor. The second difficulty presents itself in that the engineer has very little time to get the necessary agricultural information. Yet if the basic years are well planned the junior and senior years will allow possibly one-fourth time for agriculture, which should be sufficient for a mature student. A study of courses outlined shows that very little agriculture is required of the agricultural engineer who grows up under the shadow of engineering. Elective subjects and a few required courses in soils and crops are considered sufficient in some cases. In fact, we find strong defenders of the cause who say the agricultural engineering student must remain truly an engineer.

Now, in regard to subject matter: Prof. J. B. Davidson, of Iowa State College, writes: "In outlining our professional four-year agricultural engineering course, which has the distinction of being the first of its kind, we were committed to the idea that this course should be sound from the standpoint of the essential elements of an engineering training. You will note that the same amount of physics, chemistry, theoretical and applied mechanics, materials and mechanics of materials are included which you would expect to find in any engineering course." I noticed that this course as outlined at Iowa State College, Ames, has a fair portion of agriculture and that this agriculture is heavier in the upper years than in the lower. Prof. Davidson divides the work in his agricultural engineering course as follows:

	Per Cent
Agricultural engineering	14.2
General engineering	21.6
General agriculture	19.2
Science	28.4
Cultural subjects	5.5
Elective	8.2
Military and physical training	2.7

From a study of schedules at hand the course should embody the following subjects:

- Mathematics through calculus
- Engineering physics
- Surveying
- Rhetoric (technical writing or public discourse)
- Mechanical drawing
- Theoretical and applied mechanics
- Descriptive geometry
- Chemistry
- Woodwork
- Forge work
- Hydraulics
- Machine work
- Strength of materials
- Highways
- Sanitation, heating and ventilation
- Principles of economics
- Agronomy (soils and crops)
- Horticulture (landscape gardening)
- Agricultural engineering (farm machinery, farm motors, drainage, farm buildings, concrete, tractors, and an advanced course at least in machinery and motors.)

Very naturally, these subjects would vary slightly with locality and more with the inclinations of the men in charge. This is the course which we would find in the engineering college. Since the group in the agricultural college would not likely be called a four-year course in agricultural engineering, but rather a group in agriculture, it is not outlined here.

A miniature model used at the South Dakota State Fair (1920) last fall by the extension division of the South Dakota Agricultural College to encourage the bathroom in farm homes and the septic tank in preference to the leaching cesspool, and to show exactly how they are installed. Printed circulars containing the plan of the septic tank and directions for building it were given out on request

Farm Septic Tank Exhibit

By Ralph L. Patty

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THE opening gun of a campaign for "Better Farm Homes for South Dakota" was fired at the state fair in September 13 to 18, 1920. It is the purpose of the extension specialist in agricultural engineering to make this the feature project during the coming year and the first step taken was to put on an exhibit at the state fair at Huron.

The exhibit featured the modern farm house and the septic tank as used in preference to the leaching cesspool. No attention was paid to the model arrangement of rooms in the house further than those effected by the installation of the plumbing. The rear of the farm house is shown with the bathroom over the kitchen and the back entrance through the washroom. The exact method of installing the septic tank, when an open outlet is available, was shown. Some things in the plan were exaggerated in order to emphasize them. The grade in the sewer pipe was greater than necessary and the abrupt drop in the drain tile just after leaving the tank was also emphasized. The whole exhibit is set up on a platform about table high. The amount of dirt used to show the cross section was greatly reduced by building a false form under it. The dirt was covered with colored sawdust for imitation grass and sprigs of cedar were used for miniature trees on the lawn. The septic tank cross section was built of one-half inch boards and painted to look like concrete. The miniature sewer pipe and drain tile offered some little difficulty in the short time available but was solved at the last minute in a very satisfactory manner by using ordinary dowel stock. The bells of the sewer pipe were shown by a ring of heavy cardboard. The whole was then colored a deep red. The drain tile were made of the same material. They were painted a lighter red than the sewer pipe for purpose of distinction and narrow black lines were used to represent the joints. The front of the earth cross section was of ordinary double strength window glass.

A four-page circular, showing the plan of a simple septic tank for farm sewage disposal, was at hand and distributed on request. This circular also contained a brief discussion of the action of a septic tank. The demonstration was found effective for getting in touch with many small town plumbers, who are now recommending the use of the leaching cesspool.

Application of the Law of Variables to the Design of Drainage Outlets

By **David P. Weeks, M.S.**

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AN EXPLANATION as to what the law of variables is is perhaps desirable before considering its application to drainage problems.

Suppose a thousand men were picked, and the mean height of the thousand men taken by dividing the sum of all their heights by the number of men. If the men were divided into groups, there would be comparatively large groups that varied from this average but a small amount, while as the variation became larger the groups would become smaller, and at the extremes there would be a few dwarfs and one or two giants. This illustrates very well the law of probabilities.

Take for illustration the old problem that is given in most of the algebras, that of flipping a coin. With a single coin there is an equal chance of obtaining either a head or tail, and the probability of either occurrence is indicated by the fraction one-half. If now you flip six coins, the probabilities of different combinations work out as follows:

All heads	1/64
Five heads, one tail	6/64
Four heads, two tails	15/64
Three heads, three tails	20/64
Two heads, four tails	15/64
One head, five tails	6/64
All tails	1/64

If these probabilities are platted as ordinates upon an "x" axis which is divided into six equal parts the typical probability curve shown in Fig. 1 will be the result.

The Army School of Artillery Fire uses such a curve in showing where their shots will probably fall. They divide their base line into eight equal parts and figure that 25 per cent of the shorts will fall in the first space to the right or left of the "y" axis, 16 per cent in the second space, 7 per cent in the third space, and about 2 per cent in the fourth space upon the neutral axis. The resultant probability curve is shown in Fig. 2.

The general equation of the probability curve takes either one of the two forms:

(1) $y = Ke^{-h^2x^2}$

(2) $y = hd \times \pi^{-\frac{1}{2}} e^{-h^2x^2}$

e = a base in the Naperian system of logarithms

K = a constant

$$h = \frac{1}{2d \times \Delta}$$

A full discussion of this general curve may be found in "The Method of Least Squares," by Mansfield-Merriman, published by Wiley & Son, or in the "Adjustment of Observations," by Wright and Hayford, published by D. Van Nostrand Company. Allen Hazen has used this method of probabilities in a paper entitled "The Storage to be Provided in Reservoirs," published in the 1914 Transactions of the American Society of Civil Engineers. He has also written a paper which is published in "Engineering News-Record," January 6, 1916. Thorndike Saville has an article in "Engineering News," Vol. 76, No. 26, published late in 1916, the subject of which is "Rainfall Data Interpreted by the Laws of Probability."

Although proper interpretation of rainfall data is only a beginning in the solution of a complex drainage problem, it might be well to reproduce here the meat of Saville's paper with a view to discussing later a similar treatment of the practical drainage problem.

Quoting from the work of Mansfield-Merriman, Saville gives the basis of his studies as follows: "In measurements of equal precision the most probable values of observed quantities are those which render the sum of the squares of the residual errors (variations) a minimum." The arithmetic mean is the most probable value, therefore, of a series of observations of equal weight.

For the purpose of illustration, Saville makes an analysis of the rainfall at Hartford, Connecticut, for a period of forty-seven years using the following as a basis:

Z = Most probable value of a term in a series of observations

n = Number of observations

M = Any observation

v = Variation of a single observation from the mean

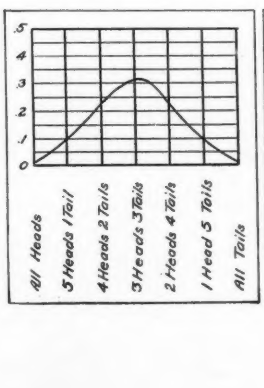
r = Probable error of a single observation

R = Probable error of the mean

$$Z = \frac{\Sigma M,}{n} \qquad r = 0.6745\sqrt{\frac{\Sigma v^2}{n\text{-}1}}$$

$$R = \frac{v}{\sqrt{n}} = 0.6745\sqrt{\frac{\Sigma v^2}{n(n\text{-}1)}}$$

The quantity $\sqrt{\frac{\Sigma v^2}{n\text{-}1}}$ is called the standard variation, and the ratio of the standard variation to the mean, that is $\frac{n\sqrt{\frac{\Sigma v^2}{n\text{-}1}}}{\Sigma M}$ is called the coefficient of variation. The coefficient



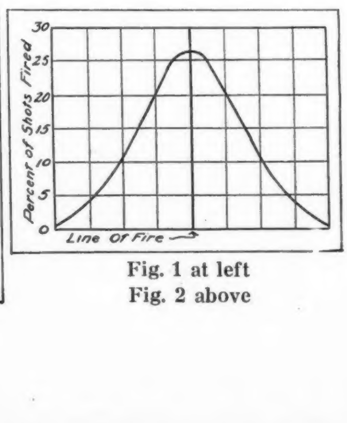


Fig. 1 at left
Fig. 2 above

The first part of the report of the committee on drainage presented at the fourteenth annual meeting of the American Society of Agricultural Engineers held at Chicago, December 28 to 30, 1920.

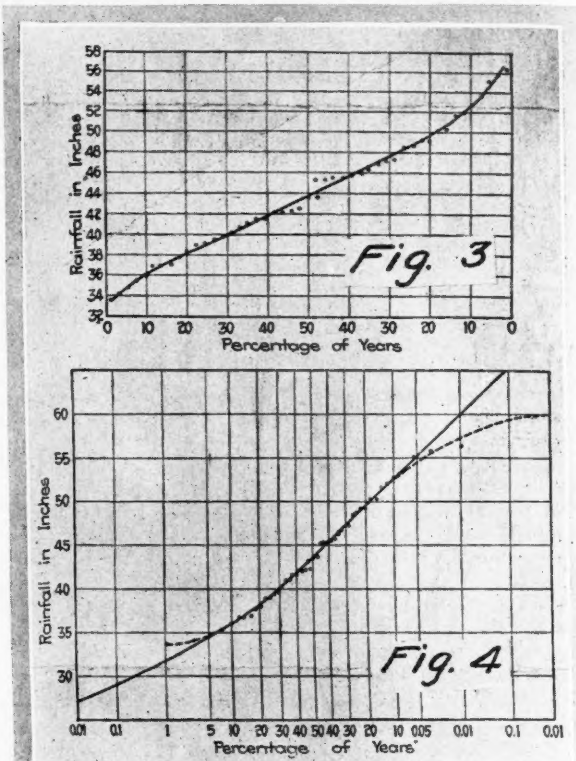
of variation is used in comparing the rainfall of one section with that of another. In some localities the variation from the mean may be great while in others, for instance on the Atlantic Coast, the variation is very small.

Fig. 3 shows each of the observations, which are arranged in order of ascending magnitude, platted as an ordinate, while the per cent that each observation is of the total is platted cumulatively as an abscissa. The abscissa 1.06 for the lowest rainfall observation is at the middle of the abscissa distance representing 2.128 per cent which is the per cent that one is of the total number of observations taken. Each subsequent abscissa is found by adding 2.128 to the previous abscissa.

Fig. 4 is the same data platted upon special paper for the purpose of getting a curve that will approximate a straight line. The abscissae intervals are made in accordance with the value of the probability integral. The advantage of a straight line is in predicting frequency of future rainfall occurrence by extending the graph beyond the limits of observation.

Now the application of the theory of probabilities to the economic design of drainage systems is an altogether different thing than the simple prediction of probabilities of rainfalls of given intensities. There are many things that may occur from the time that a drop of rain falls upon some part of a drainage area until it passes beyond the limits of the watershed. There are many things that affect the run-off from a drainage district. These factors have been understood qualitatively for a long time. It is the quantitative effect of each of these factors that is the problem before investigators today. The practicability of applying the fine spun law of probabilities to any particular drainage design is doubtful because of the many estimates that must be made as to the effect of the factors governing run-off aside from the mere variation in rainfall.

E. V. Willard, of the Minnesota department of drainage and waters, in a recent report on the drainage of the Minnesota River valley, graded the land in the valley to see how often it was flooded enough to destroy the crops. From the records of transfer in the county offices he then determined the value of the land which was subject to flood every second year, every fifth year, every tenth year, and so on. He then made estimates of the cost of the system of drainage which would provide relief for these various classes and amounts of land and in that way arrived at what he considered the most economical system to construct.



FREQUENCY OF RAINFALL AT HARTFORD, CONN., 1868 TO 1914, INCLUSIVE

Courtesy "Engineering News-Record"

WAYS OF APPLICATION OF LAW OF LEAST SQUARES

There are two ways of looking at the problem of a systematic application of the law of least squares to the economic design of drainage districts. First, the law might be applied directly to the solution of a particular problem such as the drainage of the Minnesota River valley. I do not know just how Mr. Willard analyzed the problem to determine what lands would be flooded at the intervals of time given above. Such a deduction could be based upon a hydrographic study of the valley. Works on hydrology by Meade and by Meeyer give methods of computing water yield from a drainage area from rainfall data and drainage area characteristics. Such methods may be more or less approximate according to the amount of rainfall and run-off data available. Years of maximum rainfall are not necessarily years of maximum run-off. Years of maximum run-off are not necessarily years of maximum damage. Years of maximum water yield are not necessarily years of maximum discharge or maximum damage. Years of high water in which the high stage covers some considerable time during the growing season are the years that will cause crops to be damaged or destroyed.

To what data then is the law of probabilities to be applied? It cannot be applied consistently to annual rainfall except insofar as the annual rainfall indicated the years that have probably been years of damage. A graph with years as abscissae and dollars worth of damage as ordinates could be constructed from a hydrograph in connection with a map with sufficient elevations and stream characteristics to make it possible to determine the stream stage in different portions. With this information the land could be classified and a relation could be established between stage and area flooded. Some deduction must be made as to the relation between height of flood, duration of flood, and amount of damage. The ordinate of the damage graph would be determined by the damage that would result as indicated by the hydrograph during any particular time of the year. A damage graph must be constructed for several different types of construction. The application of the law of variables to the ordinates of the damage graph will make it possible to predict the damage to be expected once in two years, once in five years, etc.

The difference between the damage where no construction is provided and the type of construction under consideration, will be the interest on the investment. There would be, however, some rather intricate adjustments for reducing this difference in damage to a rational interest basis. Of course the type of construction that will pay the greatest amount of interest will be the proper one to adopt, if the farmers can be made to appreciate these fine points.

This method of analysis, if applied at all, would require an expensive survey and study. It could only be applied to very large projects as the cost would be prohibitive on small ones. As to the practicability of its application to any district much might be said on both sides. As a matter of fact there are too many expensive projects designed and constructed without any analysis. Such an analysis, even if it is based upon many varying factors, would familiarize the de-

signer with all the available data bearing upon the success of the project. It would indeed be a guide to the judgment, and in the end the judgment would be the deciding factor in any event.

The greatest trouble which every drainage engineer meets is the lack of sufficient data upon which to base his ordinary judgment. There are few projects upon which hydrographic measurements have been made. It is necessary as a usual thing to make many assumptions throughout any such analysis; however, an experienced engineer is able to exercise his judgment very skilfully in making these assumptions. Even if hydrographic studies have been made, an estimate as to the change in run-off conditions after construction must be made.

In studying the rainfall at Hartford, Connecticut, Saville has prepared the following table:

Yearly Rainfall In Inches In Order of Magnitude	Variations From the Mean	Variations Squared	Percentage of Total For Plotting
33.64	10.34	106.92	0.0106
34.11	9.89	97.81	0.032
34.78	9.22	85.01	0.053
35.74	8.46	71.57	0.074
36.02	7.98	63.68	0.096
36.88	7.12	50.69	0.117
36.91	7.09	50.27	0.134
37.04	6.96	48.44	0.160
37.68	6.32	39.94	0.180
38.25	5.75	33.06	0.201
38.95	5.05	25.50	0.224
39.16	4.84	23.43	0.245
39.45	4.55	20.70	0.266
39.73	4.27	18.23	0.288
40.17	3.83	14.67	0.309
40.75	3.25	10.56	0.330
41.09	2.91	8.47	0.351
41.53	2.47	6.10	0.372
41.56	2.44	5.95	0.394
42.07	1.93	3.72	0.415
42.07	1.93	3.72	0.436
42.20	1.80	3.24	0.457
42.42	1.58	2.50	0.478
43.60	0.40	0.16	0.499
43.66	0.34	0.12	0.522
45.35	1.35	1.82	0.543
45.37	1.37	1.88	0.564
45.54	1.54	2.37	0.585
45.62	1.62	2.62	0.606
45.83	1.83	3.35	0.627
46.32	2.32	5.58	0.650
46.81	2.81	7.90	0.671
47.13	3.13	9.80	0.692
47.29	3.29	10.82	0.713
48.47	4.47	19.98	0.735
48.71	4.71	22.18	0.756
49.22	5.22	27.25	0.777
49.26	5.26	27.67	0.798
50.25	6.25	39.06	0.819
50.29	6.29	39.56	0.840
51.66	7.66	58.68	0.861
52.00	8.00	64.00	0.882
52.69	8.69	75.52	0.903
53.59	9.59	91.97	0.924
55.12	11.12	123.65	0.945
55.81	11.81	139.48	0.967
56.36	12.36	152.77	0.990

$\Sigma M = 2067.95$ $\Sigma v^2 = 1722.17$

$$\frac{\Sigma M = 2067.95}{n \quad 47} \qquad R = 0.6745\sqrt{\frac{\Sigma v^2}{n(n-1)}} \qquad \sqrt{\frac{\Sigma v^2}{n-1}}$$

= 44.00, the mean = 0.6020, probable error of the mean = 6.119, standard variation.

The other phase of the problem is the application of the law of probabilities in the preparation of a table of coefficients to be used by engineers throughout the country on small projects that will not warrant an analysis, or where the engineer is not inclined or prepared to make such an analysis.

The following is a summary of the present methods of selecting the run-off factor for the drainage of lands in humid sections:

1. The application of a flat rate run-off factor over a region of similar characteristics, such run-off factor having been determined by comparing the designed coefficient of successful and unsuccessful projects.

2. The measurement of discharge in constructed outlets from areas of different sizes and characteristics, such characteristics being carefully recorded and made the basis of determinations on projects to be constructed.

3. The determination of run-off from the area before drainage construction, and determining the change that the completed project might make in such run-off, the run-off determinations in the first instance being made by maintaining gauging station, or by analysis of rainfall and drainage area characteristics.

4. Arbitrary judgment based upon more or less experience.

It is proposed to group all drainage districts studied according to their characteristics. The following grouping is only tentative, but it gives an idea of the method proposed:

1. GEOGRAPHICAL POSITION (CLIMATE GROUP)

(a) North Pacific	(g) East Central
(b) South Pacific	(h) West Central
(c) North Arid	(i) East Gulf
(d) South Arid	(j) West Gulf
(e) Northeast Central	(k) North Atlantic
(f) Northwest Central	(1) South Atlantic

The boundaries of these areas to be determined by rainfall, temperature and general climatic character.

2. SIZE OF DRAINAGE AREA IN SQUARE MILES

(a) 0 — 1	(d) 50 — 100
(b) 1 — 10	(e) 100 — 500
(c) 10 — 50	(f) 500 — 1000

(g) Above 1000

3. RATIO OF ORIGINAL AREA OF WET AND SWAMP TO THE TOTAL DRAINAGE AREA

(a) .00 to 0.01	(c) 0.1 to 1.0
(b) 0.01 to 0.1	(d) 1.0 to 10

(e) Above 10

4. TOPOGRAPHY OF HIGH LANDS

(a) Hilly	(c) Rolling
(b) Very rolling	(d) Gently rolling

5. TOPOGRAPHY OF LOW LANDS

(a) Natural drainage obstructed by barriers—general slope along drainage lines greater than 0.1%

(b) Natural drainage obstructed by barriers—general slope along drainage lines less than 0.1%

(c) Natural drainage obstructed by flatness of land—general slope less than 0.03%

(d) Natural drainage obstructed by flatness—general slope between 0.03% and 0.1%

(e) Natural drainage obstructed by flatness—general slope greater than 0.1%

6. SUBSOIL CHARACTERISTICS

(a) Dense	(c) Porous
(b) Slightly porous	(d) Very porous

7. SURFACE SOIL CHARACTERISTICS

(a) Dense	(c) Porous
(b) Slightly porous	(d) Very porous

8. RATIO OF GREATEST LENGTH TO GREATEST WIDTH

(a) .05 or less	(c) 0.1 to 1.0
(b) .05 to 0.1	(d) 1.0 to 10.0

(e) Above 10.0

9. TYPE OF SYSTEM

Tile Drainage Systems

(a) With surface inlets
(b) With surface inlets or surface outlets
(c) Without surface inlets or surface outlets

Ditch Drains

(d) Complete ditch systems
(e) Ditch outlets for systems using tile in a large portion of the upper portion of the district
(f) Channel improvement of a small section at the lower end of a drainage area

10. COMPLETENESS OF THE SYSTEM. (Per cent of drainage area served.)

(a) 0-10	(f) 50-60
(b) 10-20	(g) 60-70
(c) 20-30	(h) 70-80
(d) 30-40	(i) 80-90
(e) 40-50	(j) 90-100

11. SOURCE OF BULK OF DAMAGING WATER

(a) Overflow from natural channel
(b) Run-off from adjacent lands
(c) Seepage

(This analysis is not for application to irrigated lands.)

(d) Direct rainfall

The possible number of drainage district types will be classified according to this outline, whereas if no such outline were used there would be as many types as there are drainage districts. It is proposed to treat each type separately at first and later draw conclusions from one set of data to fill in where information is wanting in another type. It might be expedient to limit studies to certain groups with the express idea of filling in between these groups when certain laws governing run-off will be better understood. It is proposed to promote investigation along the following lines:

1. The establishment of current meter gauging stations, weirs, and measuring flumes on selected drainage districts that have been constructed and upon selected drainage areas that have not been touched by artificial drainage.

2. The establishment of rain gauge stations equipped with automatic registering devices for measuring intensities as well as amounts.

3. The securing of statements from a very great number of farmers located in selected drainage districts in regard to dates when their systems have been successful and when they have partially or totally failed. Full descriptions of the drainage district should accompany each report together with the designed coefficient.

It is proposed to analyze the data thus obtained for any one particular type of district as follows:

1. Select a representative district of the type that has the greatest amount of information available for it.

2. Making use of long standing records of daily and monthly rainfall, compute a hydrograph of yield using current meter and weir data for determining constants of evaporation. Such a hydrograph will not show maximum rates of flow, but will be an indication of maximum rates.

3. Plat a mass diagram of soil storage on the drainage area using data and constants determined in (2) for this purpose.

4. Using the best daily records of precipitation available and constants determined from current meter, weir, and automatic rain gauge, make an estimate of the dollars worth of damage done each year for which data are available.

5. Plat a graph using for ordinates the damage with years as abscissae.

The law of variables would be applied to the ordinates of this graph just as yearly rainfall was treated by Saville. A table of coefficients for different land values and different costs of the drainage system could be deduced from the results of this analysis. It would be necessary to assume different land values and construct damage curves for each set of values. Using the probable difference in damage between no system and a system of a given cost as interest on the cost an economic coefficient could be selected from the table.

AUTHOR'S NOTE: Acknowledgment is due R. W. Clyde, drainage engineer of the Iowa Highway Commission, for suggestions which have been incorporated in this paper.

Results of a Drainage Investigation

By S. H. McCrory

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THE committee on drainage sent a questionnaire to two hundred and fifty-seven engineers (during 1920) located in the eastern half of the United States. Replies were received from about one hundred, of whom eighty-two completed the questionnaire.

In computing the capacity of tile drains, the Chezkutter formula is used by fifty-two engineers, Elliot's modification of Poncelet's formula by thirteen; Poncelet's formula by twelve, while other formulae are used by eight. Several engineers reported that they used two or more formulae. In using the Chezkutter formula the value of the coefficient, n, used ranged from 0.011 to 0.017. The value most commonly used seems to be $n = 0.013$ and 0.015.

The rates of runoff recommended for use in designing tile drainage systems varied greatly. Ten engineers located in Illinois, Indiana, Iowa, South Dakota, and Wisconsin report that under certain conditions they use 1/8-inch runoff; fifty-eight engineers report that they use 1/4-inch runoff; twenty-seven report using 3/8-inch; twenty-one 1/2-inch, and nineteen 5/8 to 1-inch runoff. A number of engineers pointed out that the rate of runoff varied with difference in topography, soil and precipitation, and that therefore no one rate of runoff could be adapted. In Table I are shown the states from which reports were received, the most commonly used rates of runoff, the minimum size of the grade, and the depth and spacing recommended for lateral drains.

Second and last part of the report of the committee on drainage presented at the fourteenth annual meeting of the American Society of Agricultural Engineers, at Chicago, December 28 to 30, 1920.

TABLE I

State	Rate of Runoff Inches per 24 hours	Laterals Minimum size Inches	Laterals Minimum grade Feet per 100 feet	Laterals Area Depth Feet	Laterals Area Spacing Feet
Alabama	1/4 to 1/2	4	.1	3	75
Arkansas	1/2	4	.1	3	50- 75
Illinois	1/4	5	.08	3-1/2	75-150
Indiana	1/4	4	.05	3	50-100
Iowa	1/4	5	.1	3-1/2	100
Louisiana	3/4	5	.08	3	80
Minnesota	1/4	5	.1	3-1/2	100
Mississippi	1/2	5		3	75
Missouri	1/4	5	.04	3	80
Massachusetts	1/4	4	.03	3	75
Nebraska	1/4	5	.1	3-1/2	80
New York	1/4	3	.08	2-1/2	
North Carolina	1/4	4	.1	3	80
Pennsylvania	1/4	4	.1	3	75
South Dakota	1/4	6	.1	3-1/2	100
Tennessee	1/4	5	.1	3	80
Virginia	1/2	4	.2	3	75
Wisconsin	1/4	5	.1	3-1/2	80

TABLE II Types of Soils (Subsoil) Depth and Spacing of Lateral Drains

State	Sandy loam	Depth Feet	Spacing Feet	Silty Soil	Depth Feet	Spacing Feet	Gravelly clay	Depth Feet	Spacing Feet	Clay	Depth Feet	Spacing Feet	Sand	Depth Feet	Spacing Feet	Muck or Peat	Depth Feet	Spacing Feet
Alabama	1	3.50	+160	1	3.50	100				2	3.00	75						
Arkansas	3	3.00	70	3	3.00	65				3	3.50	62						
Illinois	3	4.00	150	6	4.00	100	1	4.00	+80	7	3.33	90	2	3.75	125			
Indiana	3	3.00	100	1	2.50	-40	1	3.00	80	3	3.00	88	3	3.50	150	3	4.00	133
Iowa	9	3.86	115	10	3.63	100	3	+4.00	125	28	3.74	90	5	3.83	158	4	4.40	100
Louisiana				1	2.50	80				1	2.50	80						
Massachusetts	1	3.00		1	3.00		1	3.00		1	2.50	+ 30	1	-3.00	-100			
Minnesota	3	3.75	120	2	3.80	110	1	3.90	125	5	+ 3.63	+100		4.00	+180	1	-4.00	88
Mississippi	1	3.00	150	1	3.00	+150	1	+3.00	+150	1	-2.25	90						
Missouri				2	+4.00	150				2	2.50	50						
Nebraska	1	+4.00	105	1	3.50	85				1	3.00	65						
North Carolina	2	3.50	110							2	3.00	80						
Ohio										1	2.75	40						
Pennsylvania																		
South Dakota	1	3.33	100	1	3.67	100	1	3.67	100	7	3.14	100	1	+4.00				
Tennessee	1	3.75	110							1	3.50	65						
Virginia	1	-3.00	-75		-3.00	75				1	2.50	60						
Wisconsin	3	3.20	90	1	3.00	100				3	3.00	75	3	4.00	140	2	+4.50	132
Totals	33	* 3.51	* 110	32	* 3.52	* 98	9	* 3.62	* 114	69	* 3.37	* 85	18	* 3.78	150	10	* 4.26	* 115

* These are weighted averages

Of seventy-six engineers who reported in regard to the use of surface inlets thirty-seven increase the rate of runoff when such inlets are used; twenty-six use the same rate of runoff; seven do not use surface inlets, and the others did not report. When the rate of runoff is increased it is most commonly from 50 to 100 per cent, but there is no uniformity in the practice. Failures due to surface inlets were reported by twenty-four engineers, while fifty engineers had had no difficulties; fifty-two considered them desirable, thirteen undesirable. The failures generally consisted of deposits of silt, sand or trash in the tile.

In designing tile drains seventeen engineers make allowance for pressure head in main drains, while fifty do not.

In answering questions in regard to minimum size of tile used for lateral drains, twenty-eight reported 4-inch tile as a minimum; thirty-nine, 5-inch, and one 7-inch. The largest tiles reported as used for mains were 60 inches in diameter located in Illinois. Other large tile were reported as follows: Iowa and Minnesota, 52-inch, Ohio and South Dakota, 42-inch; Wisconsin, 30-inch. None of the other states reported over 18 inches. The minimum grade used on laterals varied considerably. Most of the engineers preferred at least 0.1 foot fall per 100 feet, but a number of them reported having laid tile with grades ranging from 0.02 to 0.05 foot. While the minimum grade used on laterals ranges from 0.01 to 0.1 foot, most engineers endeavor to secure 0.05 foot fall per 100 feet, if possible. Attention was called to the necessity of securing at least 0.2 foot fall for laterals in the Norfolk and Portsmouth series of soils in the South Atlantic states if satisfactory drainage is to be secured.

Structural failures of both clay and concrete tile were reported. Thirty-one engineers report that they have observed structural failures of clay tile; forty-two report no failures; thirty-seven report structural failures of concrete tile; thirty-five report no failures of concrete tile. Failure of concrete tile due to the action of alkalis or acids were reported from Indiana, Massachusetts, Minnesota, North Carolina, South Dakota, Virginia, and Wisconsin. Information relative to all such reported failures is being obtained.

An inquiry was made in regard to the practice of placing tile drains in old open ditches; thirty-five engineers reported that they had done this; thirty-nine had not. Of those who had had experience sixteen reported erosion; nineteen had had no trouble.

An inquiry in regard to failures of tile drains and the causes of failures produce some interesting replies. Thirty-two reported failures because the drains were too small; fourteen, poor grades; fourteen, faulty laying; ten, too shallow; eight, poor outlets; two, too deep; two, tree growths; three silting; eight, tight soil; eight, miscellaneous reasons.

An inquiry was made in regard to the effect of air circulation in the tile upon crops grown upon the land. Forty-nine engineers considered such circulation desirable; thirteen had used vents to admit additional air into the drain; six of these reported favorable results from such vents, and one unfavorable.

An inquiry was made in regard to the method of payment for engineering service. Sixty reported a per diem basis ranging from $5 to $30 per day; the average of all per diem given was $13.60. The rates most commonly given were $10, $12.50, and $15 per day. Twelve reported payment on a percentage basis with fees ranging from 4 to 12 per cent, the average being 6 per cent.

An inquiry in regard to the attitude of railroad companies toward the construction of underdrains was made. Thirty-eight engineers reported the railroad companies' attitude as favorable; twenty antagonistic; ten reported that the railroad company required their O. K. on plans before agreeing to

Table III Cost of Constructing Tile Drains in the States of Illinois, Indiana, Iowa, Minnesota, South Dakota, Wisconsin, Ohio, and Nebraska

Size of tile Inches	Depth in Feet: 3 feet or less, Cents per foot	4 feet, Cents per foot	5 feet, Cents per foot	6 feet, Cents per foot	8 feet, Cents per foot	9 feet, Cents per foot		10 feet, Cents per foot	11 feet, Cents per foot
4	4.7	7.0	7.9	12.0	16.0	25.0	32.5	40.0	
5	4.8	7.0	9.0	12.0	17.7	22.2	32.5	40.0	
6	6.1	8.6	11.2	15.6	20.3	29.5	36.2	42.6	
7	6.1	10.0	12.6	16.5	24.9	37.2	37.2	47.5	
8	6.6	10.5	14.2	17.5	21.0	33.1	38.5	49.2	63.0
10	9.3	14.6	18.2	24.7	30.1	38.3	49.6	68.9	83.0
12	11.0	15.9	19.6	25.6	31.2	39.0	64.3	65.6	91.0
14		19.0	24.4	36.1	39.2	52.0	62.4	73.7	101.0
15		22.2	27.0	38.7	41.8	55.1	66.7	75.4	106.0
16		19.0	27.3	37.6	41.2	61.6	76.5	90.6	112.0
18		23.7	32.2	44.1	47.8	63.8	76.9	90.3	121.0
20		28.0	38.1	49.7	57.0	74.8	87.4	105.9	134.0
22		30.0	40.7	57.5	62.3	79.9	98.8	114.3	144.0
24		34.7	42.8	57.4	69.5	82.5	101.0	117.0	155.0
26		48.0	47.5	73.7	79.5	199.0	118.5	145.0	165.0
27		36.0	37.7	55.1	67.3	88.3	111.0	123.0	
28		50.0	61.0	75.6	79.7	99.0	117.7	136.7	176.0
30		49.5	63.1	81.0	78.3	100.3	125.0	142.0	188.0
32			53.6	68.0	85.6	101.5	122.0	141.6	201.0
33		47.4	59.3	71.2	93.3	119.0	133.0	148.0	
34			66.0	164.0	101.0	121.0	121.0	164.0	211
36		53.3	69.8	120.3	108.5	130.3	150.0	169.5	221
39				39.4					
40				200.0					
42				42.9					
45				250.0					

Table IV Cost of Constructing Tile Drains in the States of Alabama, Arkansas, North Carolina, Louisiana, Massachusetts, Mississippi, Missouri, Pennsylvania, Virginia, and Tennessee

Size of Tile Inches	Depth in Feet: 3 feet or less, Cents per Foot	4 feet, Cents per Foot	5 feet, Cents per Foot	6 feet, Cents per Foot	7 feet, Cents per Foot	8 feet, Cents per Foot
4	5.3	5.9	7.7	9.7	13.3	
5	5.3	5.9	7.7	9.7	13.3	
6	5.5	5.6	7.7	9.7	13.3	
7	5.8	6.7	9.1	11.5	15.7	20.0
8	5.8	7.5	9.7	12.1	16.3	20.6
10	6.0	7.9	10.3	12.7	17.0	21.0
12	6.1	8.5	10.9	13.3	17.6	22.0

the work. In several instances the attitude of the same railroad company was given as different by different engineers, one reporting as favorable and others unfavorable. Apparently the personality of the engineer and county officers who come in contact with the railroad officials has a considerable bearing upon the railroad's attitude toward the project.

An inquiry in regard to the use of drainage trenching machinery was made. Nine engineers reported that trenching machines cost more than hand work; forty-six less than hand work; five about the same; while fourteen were uncertain.

An inquiry in regard to use of vertical drains was made. Forty-five engineers had not used them; twenty-eight had. Of the engineers who had used them eleven reported good results; twenty-two engineers, some of whom had not used them, thought such drains of questionable value.

An inquiry was made in regard to the depth and spacing of drains in different types of soil; the average results obtained for the different states are shown in Table II.

It should be remembered that the figures given are averages and may or may not represent the best practice for the particular state and soil.

An inquiry was made in regard to the cost of constructing drains from the data secured. Table III was compiled for the upper Mississippi Valley states, and Table IV for the Southern and Eastern states. These tables are believed to be fairly representative for 1920.

An inquiry was also made in regard to the effect the cost of tile was having on work. Sixty-seven engineers reported that the cost of tile was curtailing work; eight reported no difference; twenty-one reported that other difficulties, generally the inability to secure tile, were also interfering with their work. Several reported that the price of labor was also a factor in curtailing work.

The information obtained from the questionnaires has brought out most clearly the necessity for additional research work on factors affecting the design and construction of tile drains. Among the more important are the proper rate of runoff that should be used for the tile drains; the depth and spacing which should be given to underdrains in different soils; the best designs for catch basins, surface inlets, drops, outlet protection, etc., and information in regard to the best way of handling construction problems. The day has passed when the engineer can afford to use an extra liberal factor of safety when designing tile drains. When it is considered that there are drains contemplated or under construction, which will cost approximately $50,000 per mile, the necessity for having the drain of proper size will be appreciated. When tile and labor could be secured for about one-third what they now cost the need for extreme care in figuring the sizes of tile was not so great. It is to be hoped that additional studies in regard to the many factors affecting the design and construction of tile drain can be undertaken at an early date. Your committee would suggest the desirability of all interested in this work uniting to outline a program of research which will secure the desired information. If this were done and the work carefully conducted, much more rapid progress would be possible than has been made in the past.

Discussion of Reports

MR. PATTY: In connection with Mr. McCrory's suggestion as to the cause of the railroads being antagonistic toward the work, I would like to ask if that might not be due to the particular projects that the different engineers had submitted. One might submit a project that the railroad was favorable toward, and the other might not be so favorable for the railroad.

MR. MCCRORY: The questionnaire gave no clue as to that. There were three instances where men in adjoining counties on the same railroad reported and one reported favorably and the other two as being antagonistic. It seems as if there must be some question other than probably personality and the manner of approach. They are all underdrains and conditions were probably somewhat similar in the two states in which that occurred.

MR. HARRIS: Has any consideration been made of the number of years of experience or observation of the reporting engineers as influencing the report?

MR. MCCRORY: We did not have that information available. A great many of the men that I happened to know reported and in fact the majority of them are new. I think we got reports from some of the best men in the United States doing drainage work. Like all questionnaires we get extremes in both directions. In the case of depth and spacing, for instance, I am quite certain that the practice the questionnaire shows in regard to clay soils is not in standard practice, yet the depth is much wider than the men are using. In the question of soil, it is hard to differentiate. Even the soil men would probably not agree on types of soils. When engineers report on types of soils it is pretty hard to tell.

MR. CUNNINGHAM: I might say that the position of our Indiana railroads as a whole is rather arbitrary on the matter of drainage passing under. The point made just now that the personality of the man seeking the permission to cross the right of way is, in a large measure, responsible for the results he gets is well made. Having observed in division engineers' offices such problems, I have seen that some men got what they wanted and some did not.

Terracing to Prevent Soil Erosion*

By E. W. Lehmann

Mem. A. S. A. E. Extension Agricultural Engineer, University of Missouri, Columbia, Missouri

THAT soil erosion is one of the great problems that confronts the American farmer no one will question. The problem is a most serious one throughout the southern states; and now the farmers through the middle west and north begin to realize that they too have a problem of erosion, and the different experiment stations are investigating to determine the best method of combating it. In the South the conditions are ideal for erosion. There is much greater rainfall than through the middle states, and much of it during the winter months. The alternate freezing and thawing of the surface soil loosens a thin layer which is washed away by the heavy rain that follows. These natural conditions do not have to be reckoned with in the North.

As this problem is studied we find that its effects are much more harmful than we ordinarily suppose. I have seen many fields that have been cut up so badly by washing that they have been abandoned, in fact, millions of acres have been abandoned. Great gullies are formed in a few years when the land is neglected. There are few rolling fields in Missouri that are not washed. The same is true of the other states of the middle west. A recent report from Wisconsin states that more or less erosion occurs on 75 per cent of the farms of the

*Paper presented at the eleventh annual meeting of the American Society of Agricultural Engineers, Chicago, December, 1917.

Southwestern part of that state, while in the remainder of the state probably 50 per cent of the farms are subject to erosion. Investigation shows that throughout the rolling section of the State of Iowa, especially in the southern part, there is considerable erosion.

That soil erosion is a problem in Missouri is indicated by figures obtained at the Missouri College of Agriculture during the last two years, which indicate that as much as five per cent of the really fertile soil may be lost in one year on a gently sloping field, if the surface is left bare. This means that continuous cultivation for one generation may result in the loss of all the fertile soil on even gently rolling land, unless some measures are taken to stop it. On steep land the loss is much more rapid.

In addition to the loss of plant food there are two other harmful results of erosion. First, the physical condition of the soil becomes run down. It becomes heavy; its absorptive power is low; it is not friable, and will not work under the plow; and, secondly, the inconvenience caused by gullies forming. The latter result is most noticeable and probably the most dreaded.

There are two forms of erosion due to flowing water; sheet washing, and gullying. The injury due to sheet washing is not so apparent as the gullies that are formed, so it is usually underestimated. However, it is this type of erosion which slowly carries away the fertility of the soil, and gradually reduces the crop yields each year. Every farmer who has slightly rolling land should examine it for this kind of erosion.

There are a number of causes of erosion, among them the following practices: Continuous cultivation, shallow plowing, furrowing with the slopes, leaving the land bare in winter, neglect of gullies, and the exhaustion of organic matter. Other conditions which affect erosion are: Rainfall, character of the soil, the slope of the land, and the vegetation.

Since the washing of the soil is due to movement of water over its surface, it is obvious, therefore, that to reduce this washing action the soil itself must be treated so as to increase its absorptive power, and the surface changed to check the flow of water.

Practices That Control Erosion.—The following practices will tend to prevent or control erosion: 1. A systematic rotation of crops. Fewer cultivated crops and more of the pasture or hay crops. 2. The gradual deepening of the soil by occasional deep plowing. It is said that ten inches of loose soil will absorb two inches of rainfall. 3. The use of barnyard and green manures. This addition of organic matter will make the soil capable of holding much more moisture. 4. The use of winter cover crops. Cover crops retard the flow of water and diminish its carrying capacity, allowing more of it to soak into the ground. The roots of such plants will make the soil more absorptive. Lands very subject to erosion should be pastured all of the time. Well-sodded soils are not affected greatly by erosion. 5. Tiling of poorly drained lands, such as hillsides, allows the water falling on the surface a chance to percolate through the soil to the under drain, instead of washing over the surface. Such spots, if not drained, are easily eroded, as the soil is already wet before a rain.

Changing the surface of the soil to retard the flow of water has been practiced throughout the South for a great many years. The most common practice is contour farming. Rows are formed perpendicular to the slope and are practically on a level line. All cultivated crops are ridged and there are depressions between the rows. The destructive action of the flow of water is entirely eliminated in case of ordinary rains. The water is impounded between rows and is given a chance to soak in. Land when plowed perpendicular to the slope will not wash as badly as when plowed along the slope.

In some parts of the South no other system of plowing is used. The people who have always lived in those sections would think a man crazy if he would plow along the slope instead of perpendicular to it.

With cultivated crops the last cultivation should be as near across the slope as possible. Drill crops should be seeded across the slope, as often gullies are formed from the slight trenches cut by wheels.

While I have simply suggested a few of the methods and practices for preventing erosion, the system I wish to discuss more in detail is terracing.

The early hillside ditch was probably the first step toward the terrace. It is constructed so as to carry off the water from the hillside and protect the land below from washing. I saw a hillside ditch this summer that made possible the reclamation of a field across which there had been gullies deep enough to hide a horse. On the bank of this ditch was a road, above the road was pasture land, below it this field that after three years of reclamation work would produce fifty or sixty bushels of corn per acre. The hillside ditch, however, is not often advisable.

TERRACES USED MOST EXTENSIVELY IN EUROPE

Terraces, in their strictest sense, consist of a series of level areas resembling stair steps, the space between the risers being the part that is cultivated. This type of terrace is used rather extensively in Europe and China, but comparatively little in the United States. A definition of a terrace as applied to the protection of farm land, as given in a recent bulletin (No. 512) published by the United States Department of Agriculture, is as follows: "A terrace is any arrangement or disposition of the soil, the object of which is to retard the rapid movement of surface water and thereby arrest the process of erosion."

Types of Terraces.—Terraces have been classified as the bench type and the ridge type. Under the bench type we have the horizontal and sloping bench. Under the ridge type we have the level and graded, each of which are constructed with narrow and broad base.

The Bench Terrace.—The horizontal bench terrace is little used in this country. It is developed from the sloping type by a gradual movement of the soil down the slope. The bench terrace is best adapted for use on steep slopes up to twenty per cent. However, they have been used on slopes up to thirty per cent. They are not adapted for cultivated fields where modern machinery is to be used.

Ridge Terraces.—The narrow base ridge terrace is built three to five feet wide and from one-half to one foot high. If such terraces are spaced fairly close together, two to three feet apart vertically and thoroughly sodded, they give very satisfactory service. The level ridge, narrow base form, is not very satisfactory unless on pervious soils. The principal objection to both the level and graded narrow base terraces are: (1) Amount of tillable land is reduced; (2) Weed growth on the terrace saps the adjoining soil; (3) Seed from weeds seed the entire field; (4) A harbor for insects.

The Broad Base Ridge Terrace.—The broad base ridge terrace is taking the place of the narrow base type. In fact, it is the only really satisfactory type of terrace where the field is to be cultivated as a whole, with modern equipment. The level ridge terrace is designed to hold all water from the drainage area above the terrace, hence it must be high enough and the base broad enough to withstand the weight of the water above. This type of terrace is best suited for pervious soils. The vertical distance the terraces are spaced apart and their height must be determined by taking into consideration the type of the soil, the rainfall, the amount of absorption, and the slope of the land. In actual practice the dimensions are not mathematically calculated.

On impervious soils, the broad base graded ridge terrace is best adapted. While it is not as good a soil saver as the level terrace, it is suitable to more variable conditions, and is

the type of terrace we have adopted for Missouri conditions. On soils of open texture the terraces are laid out on very slight, if any grade; on the more impervious soils we use a fall from two to six inches per one hundred feet. A variable grade is much better than a uniform grade, as a minimum grade can be used near the upper end of the terrace and have the grade increase toward the outlet. In this way the flow of the water can be retarded, and it will run off in a thin sheet at a very low velocity, carrying a minimum amount of soil. In this way the terrace fulfills its real function.

A tendency on the part of the farmer is to want to terrace fields which are very steep, and not to do anything to those fields which have a slight slope, but on which the sheet washing takes away vast amounts of fertility each season. This is a mistake. There are many fields of slight slope which will never be terraced just because the effects of erosion are not so apparent as the gullies on the nearby hills. The benefits of terraces on slight slopes should not be overlooked. The following table gives the terraces most applicable to land of various slopes.

Terraces built on a steep slope are hard to maintain, and must be placed so much closer together that the expense of constructing them is great and it is inconvenient in cultivating the field.

Outlet.—When a graded terrace is to be constructed, the first consideration is an outlet for the water to flow. Proper cooperation between farmers makes it possible to secure outlets where otherwise it would be impossible. It is common practice to discharge the terrace out on the public road. This is likely to be objectionable in some cases. A permanent, well-sodded pasture or woodlot are ideal places to discharge the water from the terraces. Sometimes a large ditch which cannot be eliminated can be used as an outlet. In this connection a soil saving dam may be installed. Under some conditions a hillside ditch may be provided. I have constructed terraces having several discharges into one sink hole.

In laying out terraces there are no hard and fast rules which one must follow. Each field will have a special problem. One should look over the field thoroughly and use his best judgment in the matter. It is usually advisable to run one contour line across the field, as the slope may be deceiving. It is best practice to discharge the water in an opposite direction to the natural flow of the streams. Some writers advise that the terraces near the top of the slope be laid out first. In actual practice this does not often prove to be the correct method of procedure. There are often gullies that have already formed on the slope or there may be a particularly steep place or other obstruction in the field. If such is the case the first terrace should be laid out just above this point. All other terraces both above and below are laid out with reference to the first one.

The actual work of laying out a terrace is best done by three men, one man to handle the instrument, which should be set up at a point from which several terraces can be laid out, one man to handle the level rod, and one end of the chain and pins, and the third man to hold the other end of the chain and drive in stakes. Instead of using a regular chain or tape, it is found convenient to use a wire of desired length, one end of which is attached to bottom of rod carried by first chain-man and the other attached to a pin which can be stuck in the ground by the second chain-man while he is driving in a stake and while the first chain-man is locating the next point. Readings should be taken at intervals of fifty feet along the line of the terrace, except at ditches or where the surface of the ground is uneven, when the readings should be taken at shorter intervals. When sufficient help can be secured the terrace can be marked out with a plow as fast as it is laid out with the instrument.

It is always advisable to build the terraces near the top of the hill first. This precaution is necessary because a heavy rain might wash out the lower terraces if built first. After the terraces have been staked out, care should be observed in running the first furrow. It should follow smooth curves, and in crossing low places instead of making sharp bends to follow the contour it is best to build the terrace straight and higher. The actual construction of a terrace may be done in several ways. The most common methods are: By means of a plow, plow and V-shaped drag, plow and grader, and with the grader only.

In constructing a terrace with a plow the furrows are thrown together until a land fifteen to twenty feet has been plowed. Then commencing at the center again, the strip is plowed as before.

It requires several plowings to get the terrace of the desired height. When the drag is used three or four rounds are made with the plow and it is then dragged toward the center. The drag should then follow the plow, shoving each furrow toward the center of the terrace. As the terrace is being finished it is desirable to work only from the upper side. This makes a reversible drag a very useful implement. A road grader is used in practically the same manner as a drag. When the soil is in the right condition the grader will do the work better and faster than the drag. On some fields it is necessary to plow when the grader is to be used. When the terrace crosses a ditch or a low place a slip scraper can be used to advantage. If very much water is impounded at such places the use of a tile laid along the ditch or low place is advisable—a similar layout to the soil saving dams as originated on the Christopher farm in Missouri. If a tile is not provided above the terrace at each low place a pond will be formed after each heavy rain. Such places are quickly filled up and the ditches eliminated.

The actual cost of terracing is a subject on which there is very little data. It is affected by the slope of land and the type of soil. One good thing about this work is that the expense is almost entirely a labor expense, and can be done at a time when the farmer is not very busy during the fall of the year, after the small grain is harvested and before the plowing has begun.

The new terrace should be watched as it is liable to failure. Usually the first year, before it has become thoroughly settled, it should be sown to a crop which does not require cultivation. In the south I have seen terraces sown to pea vines the first year, also sorghum. After they have been established as a permanent feature of the field they require little attention other than throwing the soil toward its center when plowing. The field will gradually assume an appearance of a series of waves. Some attention must be given to the outlet so as to protect it from washing into the field. The practice of keeping a strip of ground at the outlet in grass or sod is used with success.

The terrace is a simple and effective means of combating erosion and can easily be constructed by men of average intelligence. With the present need of maximum production and conservation of food the use of the terrace as a means of conserving fertility and reclaiming waste land for the production of crops should and will be increased.

TYPES OF TERRACES MOST APPLICABLE TO LAND OF VARIOUS SLOPES
From Bul. 512, U. S. Dept. of Agri.

Kind of Terrace	Per Cent	Type of Soil	Grade of Terrace
Horizontal and sloping bench	15 to 20	Fairly Pervious	Level
Broad-base level ridge	3 to 15	do	do
Broad-base graded ridge	3 to 15	Impervious Worn Out	Preferably Variable 0.0 to 0.5 Per Cent*
Broad-base level ridge with tile drainage	3 to 15	Any Type	Level

*Grade will depend on the length of the terrace, but it is advisable not to exceed a grade of 0.5 per cent if possible.

William Louden
Hon. Mem. A.S.A.E.

IN ELECTING to honorary membership William Louden, of the Louden Machinery Company, Fairfield, Iowa, the Council of the American Society of Agricultural Engineers has given recognition to something more than engineering ability. In addition to a high order of inventive ability Mr. Louden has through a long and busy life displayed the unusual vision of being able to see human need unrecognized by those on whom it bore. His has been a productive life, not so much as a manufacturer of goods to meet established demands as in the creation and perfection of new devices inherently valuable but for which appreciation had to be developed.

It has been fifty-four years since he invented his first hay carrier. It met with the opposition and suspicion which attaches to practically all labor-saving inventions, because it seemed immoral to that trait in human nature which finds a virtue in performing unnecessary hard work. At that time he manufactured his devices on a farm near Fairfield and sold them in such territories as he could reach by travelling with a team. Even then farmers were so skeptical that he could sell the hay carriers only by installing them and waiting until they had been successful through a season's work before he received pay for them.

Mr. Louden's hay carrier, although seemingly a simple device, has had far-reaching effects. It has revolutionized barn architecture, as will be appreciated when it is recalled that prior to the development of the hay carrier it was unpracticable to build barns, at least so far as hay storage was concerned, higher than a man could pitch hay by hand. Not only has the hay carrier made possible high barns with deep mows, but it has rendered obsolete the barn bridge and driveway, with their attendant waste of space both inside and outside the building.

The litter carrier, which recently has been the subject of standardization work by the Society, was another of the more important devices developed by Mr. Louden, and he holds the first United States patent on this device. It is an excellent example of the mechanical imagination and understanding of agricultural conditions which enabled him to make inventions of great practical value.

Much of Mr. Louden's work has had to do with developing equipment for dairy barns. Among this may be mentioned stalls of all-steel construction and watering bowls. In the latter device Mr. Louden developed a design in which the water remaining after an animal stops drinking drains out automatically and in which there was no possibility for flow between one bowl and another, these features being of importance in preventing the spread of contagion in case of disease.

WILLIAM LOUDEN

Now in his eightieth year, Mr. Louden continues actively in the business which bears his name and his judgment is influential in guiding its policy. However, ever since 1888, when the entrance of a younger brother into the firm relieved him largely of executive duties, his work has been predominantly that of the inventor and engineer rather than the business man.

Engineering Increases Capacity of Individual Worker

By Geo. W. Iverson
Mem. A.S.A.E. Advertising Manager, Advance-Rumely Thresher Company, Laporte, Indiana

I BELIEVE agricultural engineering is due to become one of the greatest of the agricultural branches. In all its phases it touches practically everything done on the modern farm.

While I am best acquainted, however, with the tractor and power-farming side, this one alone should become of a size to equal the automobile industry before a great many years. I see a number of reasons for this, one of which is the increase in land values. In order to make the increased investment in farm lands pay the cost of operation must be reduced and the yield increased, and machinery is the only logical solution. A number of years ago it was considered that a one-man hundred and twenty acres; today it is usually considered that a one-man farm consists of 160 acres. A two-man farm, formerly considered as consisting of one hundred and sixty acres, is now considered to be about two hundred and forty acres. This means that we have already seen increased production per man and the tendency is for a much larger in the future.

Another reason is that farm labor will not work on the old twelve to fourteen-hour working day. They demand, and are getting in many cases, the eight and ten-hour day.

Naturally, with such forces as these at work, the demand for labor-saving machinery is bound to have a steady but none the less remarkable growth in the next five or ten years. Power farming has passed the experimental stage and the majority of good farmers are adopting it either wholly or in part. They realize its value and want to come to it as soon as possible for them to do so.

Reprinted from "Farm Engineering."

AGRICULTURAL ENGINEERING

The Journal of the American Society of Agricultural Engineers

Contributions of interest and value to the agricultural engineering profession are solicited from members of the Society and others. Communications should be addressed to the Editor, Sta. A, Ames, Iowa.

Double Membership in Thirty Days

SECRETARY HANSON has requested me, as one of the membership committee, to suggest a way to increase the membership of our Society during 1921.

There is no doubt but that there are a large number of agricultural engineers who would be glad to come into the Society if they knew about the benefits they would derive from associating with other members of the American Society of Agricultural Engineers.

The Society is doing good work all along the line, and what it needs in order to do better work is a little more money, and in order to get more money it is necessary to get more members. There is a way in which I am firmly convinced that the membership can be materially increased in a very short time, and that is by every member of the Society making it his special business to get into personal contact with one or two of his acquaintances and tell them about the Society and what it is doing, explaining the fact that it is a compliment to any engineer to be asked to join this Society and that he will get a great deal of good from contact and working with the large group of college, professional, and commercial men who are active in the work of the Society.

Pick out your men carefully and then go after them and get them. I have had no trouble in getting every man I have ever approached, and I firmly believe that there is not a member of our Society who cannot turn in one or more applications inside of thirty days if they will just make up their minds to do it. We have a membership of about seven hundred now. Think what it would mean to the officers and older members who have been devoting days and months of hard work to putting the Society where it is now if they could see the membership doubled in thirty days.

I am going to ask Secretary Hanson to put three application blanks inside of each member's Journal for May and I am going to see to it that my three are used—one hundred per cent.

L. C. LANDIS

Fulfilling our Mission

THE fundamental object of the American Society of Agricultural Engineers is the dissemination of agricultural-engineering information for which the chief medium or vehicle is our Journal, AGRICULTURAL ENGINEERING. In order that AGRICULTURAL ENGINEERING may fulfill its mission, which is likewise the mission of the Society, the cooperation of the members of the Society is constantly needed.

The aim of the Society is to establish itself as the headquarters or principal clearing house for agricultural engineering information and data. The purpose of the Journal is to keep members of the Society posted on the developments in this field and to keep members and the public at large informed of all important projects under way, just beginning, or in contemplation, which are of particular interest to the agricultural-engineering fraternity. The publication committee of the Society has undertaken to get in touch with members whose accomplishments in the field of agricultural engineering are such as to place them in position to give the Society valuable information and data that should be put into circulation. The members thus far approached have responded nobly and the publication committee takes this occasion to thank them for the splendid cooperation which has already been given.

Thus far some very excellent material on the various phases of agricultural engineering has been promised by members of the Society and will appear in future issues of AGRICULTURAL ENGINEERING. Agricultural engineers now have a journal that they can call their own and the publication committee is already finding that it is going to be able to secure some very valuable material which has thus far never been widely disseminated, due largely to the fact undoubtedly that publications at present in existence were not or did not aim to serve the field of agricultural engineering as does our Journal.

There is still further need, however, for members to keep the publication committee advised of anything that would be of interest to agricultural engineers, more especially of work of an investigational, experimental, or research nature. Not only will AGRICULTURAL ENGINEERING be of service to civilization in the dissemination of information that is already in existence but unquestionably it will do much to stimulate activity along agricultural-engineering lines, particularly in the matter of research. Members of the Society are therefore asked to send the publication committee topics of interest that they would like to see discussed in AGRICULTURAL ENGINEERING and authors who are capable of writing on such topics. The committee is particularly interested in investigational, experimental, and research projects, whether conducted in educational or commercial institutions.

RAYMOND OLNEY

Why a Reclamation Section

THE Council has approved the formation of a Reclamation Section in the American Society of Agricultural Engineers. While the Society always has embraced within its scope both logically and in practice matters of drainage, irrigation, flood control, land clearing etc., the formation of a special Reclamation Section will permit more intensive work along these lines and more closely knit cooperation among the workers.

In the organization of this section the Drainage and Irrigation Committees are cooperating with the Membership Committee. In addition to the many prominent men now members of the Society and engaged in reclamation work it is expected that the formation of the special section will result in the enlargement of the Society membership among reclamation engineers. It is planned to hold special section meetings in addition to devoting a proper amount of attention to reclamation at the annual meetings of the whole Society. The section meetings will of course concentrate on strictly reclamation subjects.

The organization of the Reclamation Section also is expected to facilitate and promote research in reclamation subjects and it is hoped that projects of this sort soon will be undertaken.

The Society feels that in organizing the Reclamation Section it is meeting a genuine need because heretofore there has been no such section in any national technical organization, nor in fact any comprehensive organization with engineering aim in the reclamation field.

FRANK P. HANSON

A. S. A. E. ACTIVITIES

Additional Committee Appointments

IRRIGATION COMMITTEE

H. E. Murdock, Bozeman, Montana, chairman; A. H. Hoffman, Elmer E. Moots, and R. B. West.

Texas Student Branch Organize

A STUDENT branch of the American Society of Agricultural Engineers was recently organized at the Texas Agricultural and Mechanical College. The organization was started with an enrollment of twenty members, which is an excellent beginning and augers well for the success of this branch.

This branch recently took an important part in the conduct of a power-farming demonstration put on by the agricultural-engineering department of the Agricultural and Mechanical College of Texas for a banker-farmers conference held at College Station on March 3, the purpose of which demonstration was to point out a few of the many things which the agricultural-engineering department is endeavoring to teach students who take work in that division.

Disk-Harrow Investigation

IN AN effort to reaffirm the elimination of cutaway and spading disk blades which were eliminated as a war-time economy measure, the plow and tillage implement department of the National Implement and Vehicle Association at a meeting on September 16, 1920, recognizing the contention of a few manufacturers who favored the reinstatement of the cutaway and spading disk blades, took action requesting the American Society of Agricultural Engineers to conduct field trials comparing the relative merits of solid and cutaway blades, particularly as regards advantages to the farmer and considering the higher cost of cutaway blades. The Society undertook an investigation to determine if it is feasible to eliminate the cutaway blades and standardize on the full blade for disk harrows, and a subcommittee appointed by President E. A. White, and consisting of Prof. E. V. Collins, Iowa State College, chairman; Prof. C. I. Gunness, Massachusetts Agricultural College; E. J. Stirniman, University of California; Prof. A. E. Brandt, Oregon Agricultural College; and Prof. L. J. Smith, Washington State College, was appointed to carry on the work. This committee is a subcommittee of the general tractor-drawn-machinery committee, of which Theo Brown, Deere & Company, is chairman. Final report will be submitted to the Standards Committee of the Society, of which Raymond Olney, of The Power Farming Press, St. Joseph, Michigan, is chairman.

The initial work on this investigation was to prapare the following outline of procedure:

1. Find out where the cutaway disk is used, the chairman of the subcommittee to send a letter to manufacturers of disk harrows to find out if they make and sell cutaway disks, and if so, in what territory they are sold.

2. Find out where the cutaway disk is preferred by users, this information to be obtained from manufacturers, county agents, dealers, and a selected list of farmers.

3. Field tests and investigations to be conducted to determine the comparative draft and quality of work of harrows equipped with solid and cutaway blades, these tests to be made by agricultural colleges and the United States Department of Agriculture in places where the cutaway is popular and in some other sections of the country. A standards sheet for draft tests and studies of the quality of the work also to be prepared.

Early in March of this year a meeting, which was attended by Prof. E. V. Collins, Theo. Brown, and E. A. White, president of the Society, was held at Moline, Illinois, at which time the foregoing plan of action was gone over in detail and the methods of procedure discussed. It was agreed, in addition to the questionnaire method of investigation, that the members of the committee should make thorough field tests and observations in order to determine the relative value of the two types of disk blades.

At the present time Prof. Brandt, of the Oregon Agricultural College, has made plans to conduct extensive field tests as soon as weather conditions will permit.

Prof. E. V. Collins, of the Iowa State College, chairman of the subcommittee in charge of the investigation, is conducting a series of field tests. A preliminary report of his work is contained in the following paragraphs; however, the progress of this work has been greatly interfered with by unfavorable weather conditions.

Replies to the questionnaire sent by Prof. Collins to manufacturers up to April 20 had been received from thirteen prominent manufacturers. Only one company reported that it had been manufacturing cutaway disk harrows since its elimination during the war at the request of the War Industries Board. The advantages and disadvantages which the several manufacturers advanced regarding the cutaway disk are as follows:

ADVANTAGES

(1) Penetrates the ground easier.
(2) More effective in stony soil.
(3) Does more efficient work in hard, baked land.
(4) Lighter in draft.
(5) Cuts sod to better advantage.

DISADVANTAGES

(1) It does very uneven and ragged work.
(2) Does not pulverize as thoroughly as the round blade.
(3) Is not as satisfactory for general work as the round blade.
(4) It is much more difficult to sharpen.
(5) It is short lived and has a larger percentage of breakage.
(6) It is more expensive to manufacture.

In the returns from the questionnaire three manufacturers claim it has no advantages whatever. One states that it does better work on stony ground than the full disk but that the spring-tooth harrow is much better adapted to this work than either the full-blade or cutaway disk harrow.

Reports on the cost of manufacture vary from the same to forty cents per disk in favor of the round blade.

Eleven of the thirteen manufacturers heard from are in favor of the continued elimination of the cutaway disk. One report states that the company is not making a cutaway disk but the officials feel that there is a real place for this implement in very limited territories. Another company claims that ninety per cent of its trade calls for the cutaway disk, and that they do not expect to discontinue manufacturing it.

General statements from the various manufacturing companies would indicate that the demand for the cutaway disk in the corn belt has also disappeared. There is some demand for this implement in Virginia, Florida, Georgia, and the Carolinas. There is a very lively demand in the Portland (Oregon) territory and also in certain localities in Washington and California. It appears to be the impression among

many manufacturers that the greater part of the demand for the cutaway disk has been created by sales pressure rather than the value of this implement. A list of localities where cutaway disks have been sold in considerable quantities has been secured from the manufacturers together with a list of the dealers handling them. With this information the investigation will be carried on as rapidly as possible.

Although unfavorable weather conditions have greatly interfered with the progress of tests outlined by Prof. Collins, he was able to undertake a series of tests previous to the time of making this report. The object of these tests was to determine the difference in draft using two eight-foot disk harrows, just alike except that one was equipped with sixteen-inch round blades and the other with sixteen-inch cutaway blades, with six points each. The tests were made on black loam rather wet and included sod, plowed sod, corn stubble, and corn-stalk ground. The levers were set the same for both disks and the same man rode both implements. The results secured were as follows:

	Sod	Plowed Sod	Corn Stubble	Corn Stalks
Full disk	470 lbs.	610 lbs.	450 lbs.	400 lbs.
Cutaway	550 lbs.	680 lbs.	510 lbs.	480 lbs.
Difference	80 lbs.	70 lbs.	60 lbs.	80 lbs.

Prof. Collins has made the following observation as a result of these tests:

(1) The points of the cutaway blades go deeper than the full disk blades which may account for the difference in draft.

(2) In sod the full blade cuts the sod and turns up the edges while the cutaway blades tear out small chunks of the sod.

(3) In corn-stalk ground there is a tendency for the stalks to find a notch in the disk and not be cut.

(4) While the cutaway makes a good showing from general appearances of the ground, it seems to dig out little holes rather than loosen the entire surface.

Reports have been received from four farmers in central Iowa using the cutaway blades on the rear of tandem disk harrows. Of these men two prefer the full-blade disks on the rear section. One states the advantages are about equal, and one prefers cutaway blades on the rear.

The foregoing report was submitted at the annual meeting of the plow and tillage implement department of the National Implement and Vehicle Association at its annual meeting on April 21, 1921. The reception given this report and the representatives of the Society for their cooperation was very gratifying to say the least. The manufacturers are very much pleased with the cooperation which they are getting from the American Society of Agricultural Engineers and these cooperative efforts will unquestionably be extended.

Left-Hand Plow Investigation

DURING the war, as a measure of economy, the farm-implement manufacturers, at the request of the War Industries Board, discontinued the manufacture of the left-hand type of plow. At a meeting of the plow and tillage implement department of the National Implement and Vehicle Association on September 16, 1920, unanimous action was taken by the department to request the American Society of Agricultural Engineers to make an investigation of the utility of the left-hand plow as compared with the right-hand plow, and make a public report of its findings.

Early in the present year President E. A. White, of the Society, appointed a subcommittee consisting of Prof. G. W. McCuen, Ohio State University, Chairman; Prof. C. I. Gunness, Massachusetts Agricultural College; Prof. R. U. Blasingame, Pennsylvania State College; Prof. William Aitkenhead, Purdue University. This is a subcommittee of the Society's committee on horse-drawn machinery, of which L. W. Chase, of the Chase-Tinsman Plow Company, Lincoln, Nebraska, is chairman, and the work is under the general supervision of the Standards Committee, of which Raymond Olney, of The Power Farming Press, St. Joseph, Michigan, is chairman.

The investigation as outlined is as follows:

1. Locate the left-hand-plow territory.
2. Conduct an investigation among manufacturers, dealers, county agricultural agents, and farmers as to why the left-hand plow is preferred and determine if the general situation will be benefitted by its complete elimination.
3. Send questionnaires to farmers in left-hand-plow territories to determine their attitude and the various factors involved in changing from the left-hand to the right-hand type.
4. In addition to this investigation each member of the subcommittee will be required to make a personal investigation in his own territory and report his findings and recommendations independent of other members of the committee. The final and complete report of the subcommittee will be reviewed by the standards committee and recommendations made as to what action be taken on the basis of the findings of this investigation.

The foregoing outline was presented at the annual meeting of the plow and tillage implement department of the National Implement and Vehicle Association, April 21, 1921, and met with their entire approval.

A Farm Machinery Department at Pennsylvania

A LETTER has been received by the Secretary of the Society from Prof. R. U. Blasingame, of Pennsylvania, to the effect that a department of farm machinery has been authorized by the board of trustees of the Pennsylvania State College, of which Prof. Blasingame is to become the head. Prof. Blasingame has been in charge of farm-machinery work at Pennsylvania for some time and it is of particular interest to members of the Society to know that agricultural engineering has been recognized by Pennsylvania and that a separate department is soon to be organized. No doubt this can be attributed very largely to the good work of Prof. Blasingame.

Agricultural Management

A MANAGEMENT organization for agricultural enterprises may be a new idea to some, although the business world is familiar with the management of public utilities and industrial enterprises by companies organized for that purpose. In view of the fact that the principal limiting factor in a more general development of agricultural resources in the South, West, and Latin-America is lack of experienced business-technical management, it is interesting to note that the Morse Agricultural Service, New Orleans, Louisiana, has been retained to manage the 18,000-acre W. C. Ranch of the Bowie Lumber Company, Ltd., Bowie, Louisiana. This ranch has a large number of hogs and cattle, including a fine herd of purebred Herefords, and raises sugar cane, corn, and other crops. The Morse Agricultural Service, of which Stanley F. Morse (Mem. A.S.A.E.) is the head, has a large clientele in the South, West, East; Mexico and Cuba.

Palestine Needs Agricultural Engineer

A COMMUNICATION received by Secretary Hanson from the Zionist Society of Engineers and Agriculturists through the vice-president of its agricultural department, J. W. Pincus, states that the occupation of Palestine under the British mandate as a home land for Jews requires, among other things, the services of agricultural engineers to aid in the establishment of modern agricultural production methods. Observers recently returned from Palestine state that farming there is extremely primitive in its methods, and that

the introduction of labor-saving machinery is essential.

One of them, an engineer, has suggested that there should be established agricultural machinery units composed of tractors, grain threshers, and similar machinery which should be available for use either by colonies or individuals. It is presumed that these units would undertake, probably by contract, to perform tillage and harvesting operations. The plan as thus far developed contemplates an agricultural engineer as the head of each unit, with five or six assistants to instruct the settlers in the use of the machinery.

The cooperation of our members, particularly those who through connection with farm-machinery manufacturers or otherwise are qualified to give constructive suggestions regarding the organization and equipment of the proposed units, is invited by the Zionist Society of Engineers and Agriculturists, who may be reached in care of Mr. Pincus, 118 East 28th Street, New York City.

Personal Items of Members

C. S. Bristow, consulting engineer, formerly connected with the J. I. Case Threshing Machine Company, Racine, Wisconsin, is now going into business at Portland, Oregon.

J. Bertino de M. Carvalho is Directoria Geral da Industria Pastorial, Rua Matta Machado, Rio de Janeiro Brazil, in charge of the oil and fat laboratory. He is devoting particular attention to a study of all Brazilian vegetable and animal fats.

J. P. Fairbanks is now president of the Pullman Engineering Company, Pullman, Washington. Mr. Fairbanks was formerly in charge of the agricultural engineering department at the Washington State College.

H. W. Ferris, who is on a trip through Europe, writes from Avignon, France, that he will take part in the national tractor demonstration to the King of Belgium in Brussels the first part of April. He is getting a large amount of valuable material there on tractor work.

Reuben Kuempel, formerly connected with the engineering department of the Hyatt Roller Bearing Company, tractor and implement bearings division, Chicago, Illinois, is now president of the Kuempel Company, engineers and manufacturers, Guttenberg, Iowa.

E. W. Lehmann, formerly agricultural engineering editor of "Successful Farming," Des Moines, Iowa, is now in the agricultural engineering extension department at the University of Missouri.

Urge Passage of Nolan Bill on Patents

THE members of this Society are urged to give prompt attention to the present status of the Nolan Patent Office Bill H. R. 11984, which is of particular interest to all engineers. The patents committee of the American Engineering Council of the Federated American Engineering Societies presents the situation as follows:

"The bill for the imperatively necessary relief of the Patent Office, after passing the House of Representatives with satisfactory provisions for the Patent Office, failed to pass the Senate at the session just closed with those same provisions, solely because of the presence in it of an unrelated section known as the Federal Trade Commission Section.

"The former opposition in the Senate to the Patent Office relief and that which forced the unacceptable reductions in salaries and numbers of examiners and clerks (which the conference committee was persuaded to set aside) is largely and seemingly almost wholly overcome. But the opposition in the Senate to the Federal Trade Section is determined and has expressed an intention to prevent the Patent Office from getting the desired relief, unless the Federal Trade Section is removed from the bill.

"More than preventing the Patent Office relief, however, the Federal Trade Section is believed to be a dangerous measure in itself. It provides that the Federal Trade Commission may receive assignments of and administer inventions and patents from governmental employes and is an entering wedge for further legislation to empower the Trade Commission to receive patents from non-governmental inventors or owners. An exclusive license would have to be granted, at least for a few years, to induce anyone to undertake the almost always necessary development expense, and the Trade Commission would surely be charged with favoritism in granting such a license. In order to protect its licenses, the Trade Commission would have to sue infringers, a most unfortunate activity for the government. The industries would close their doors to the government employes fearing to disclose to them their secrets or unpatented inventions, and research by the industries would be discouraged for fear that government employes, using government facilities, might reach the result first and patent it. The Trade Commission, owning a large body of patents in case that one of its patents was found to be infringed during or at the close of a frequently very expensive development by private interests, would be able to dictate in the license the price at which the article, which was the object of the development, could be sold, or to dictate other similar conditions, thus depriving the development of much of its value; and could even require the licensee, as a condition for granting needed license, to practically destroy some of its unrelated patents, as by licensing the trade generally when it would prefer to retain the monopoly for itself.

"The foregoing and other objections would result in making patents less desirable to own or to purchase, and consequently would decrease the incentive to produce inventions, which production is the main purpose of our patent system.

"The proposed section is unnecessary for the protection of government employes, since they now have all the rights which non-governmental employes have to patent inventions and sell them. It is therefore believed that the Federal Trade Commission section should not be enacted into law in any form, even as a separate bill."

Members of this Society are requested to write their Representatives and two Senators in Congress from their respective states and the chairman of the Committees on Patents of the Senate and House of Representatives (without naming the chairmen as it is not known who they will be) urging them to eliminate the Federal Trade Commission Section from the Nolan Patent Office Bill H. R. 11984, and prevent such section from becoming a law in any form, and to reintroduce the bill at the opening of the special session of Congress to begin April 4, and pass the bill at once.

Cement Specifications Made Uniform

COMPLETE agreement has been reached on specifications and tests for Portland cement, so there is now one specification covering both commercial and governmental use. Only minor changes were necessary in order to eliminate slight but long-standing discrepancies which had existed between the industrial specifications and those of the government.

The revised specifications, which were agreed upon by Committee C-1 of the American Society for Testing Materials and the government departmental committee on cement, have received the approval of the American Engineering Standards Committee.

Copies may be obtained from the American Engineering Standards Committee, 29 West 39th Street, New York, or from the American Society for Testing Materials. The price is 25 cents.

American Engineering Standards Committee

ALTHOUGH the American Engineering Standards Committee has been actively at work for only slightly more than one year, and much of the time and effort of the committee has necessarily been spent in laying a basis for work, the fruition of which will require at least two are three years, yet considerable progress has already been made in the unification of the more important standards and in overcoming the confusion that was being produced by the numerous organizations (more than one hundred) that hitherto published engineering standards without systematic cooperation among themselves.

Prior to December 31, 1920, there had been approved by the committee (1) tentative American standard specifications and tests for Portland cement, (2) tentative American standard specifications for fire tests of materials and construction, and (3) American standard pipe threads. Moreover there had been submitted for approval by the Committee the national electrical code as an American Standard, and standard test for toughness of rock, standard method of distillation of bituminous materials for road treatment, and standard method of sampling coal, as tentative American standards, with the safety code for head and eye protection submitted for approval as recommended American practice.

The committee itself is composed of forty-seven members representing seventeen bodies or groups of bodies, including six national engineering societies, five Governmental departments, and thirteen national industrial associations. Its function is merely to see that each body or group concerned in a standard shall have opportunity to participate in its formulation which is in the hands of a working committee, technically called a "sectional committee." Each sectional committee is organized by, and under the leadership of, one or more of the principal bodies interested, such bodies being known as "sponsors." Sponsorships have been arranged for the following projects which were under way by the beginning of this year:

ELECTRICAL PROJECTS: Rating of electrical machinery; and term-markings for electrical apparatus.

MECHANICAL PROJECTS: Ball bearings; plain limit gauges; gears; machine tools; nut and bolt heads; pipe flanges and fittings; screw threads; shafting.

GENERAL PROJECTS: Passenger and freight elevators; color scheme for pipe lines; steel shapes; zinc ores and zinc.

SAFETY CODES: Aviation safety code; construction work; electrical fire code; electrical safety code; floor openings; railings toe boards; foundries; gas safety code; grinding wheels; head and eye protection; ladder code; lightning code; lightning protection; logging operations and sawmill machinery; machine tools; mechanical transmission of power; paper and pulp mills; electrical power control; power presses; mechanical refrigeration; industrial sanitation; stairways, fire escapes and other exits; textiles; ventilation, and woodworking machinery.

As will be seen from the above lists, an important part of the committee's work relates to safety codes. On December 8, 1920, at a conference at which more than one hundred organizations were represented it was unanimously voted that a comprehensive program of safety codes should be undertaken, to be carried out under the auspices of the American Engineering Standards Committee to insure proper coordination and elimination of overlap, etc. Active work is now in progress on twenty-four such codes with hearty cooperation among the state commissions, associations of insurance companies, national engineering societies, manufacturers' and industrial associations, labor and civic organizations, and technical bureaus of the federal government. As is true of all work under the auspices of the American Engineering Standards Committee, such of the bodies as are interested in the particular code in question are represented in the committees responsible for the formulation of each code.

Copies of the report may be obtained by addressing a request to the American Engineering Standards Committee, 29 West 39th Street, New York.

Applicants for Membership

CARL A. SCHOLL, associate professor farm mechanics, University of Illinois, Champaign, Ill.

Ward Cretcher, instructor in soils, Oregon Agricultural College, Corvallis, Oregon.

Louis Gerbig Heimpel, chief power farming division, Ford Motor Company of Canada, Windsor, Ontario, Canada.

Clarence C. Johnson, instructor department of agricultural engineering, State College of Washington, Pullman, Washington.

Harvey S. Looper, fieldman and assistant manager, Great Western Sugar Company, Lovell, Wyoming.

Francis L. Spoor, Carnation Milk Products Co., Berlin, Wisconsin.

John Henry Swenehart, associate professor agricultural engineering, University of Wisconsin, Madison, Wis.

Albert Charles Todd, factory sales manager, Moline Plow Company, Rock Island, Illinois.

Frank B. White, vice-president and counsellor agricultural advertising, farm markets and community development, The Arthur M. Crumrine Company, Columbus, Ohio.

Jesse George Whitfield, drainage specialist, Demopolis, Alabama.

Mark Earl Simon, instructor in agricultural engineering, Allen Township Centralized Schools, Van Buren, Ohio.

Raymond C. Cosgrove, sales engineer, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

Elmore Preston Ross, president, The E. W. Ross Company, Springfield, Ohio.

Oscar Van Pelt Stout, president and general manager, The General Farming Corporation, Consulting Engineer, Lincoln, Nebraska.

Irvin D. Mayer, farm and cement products bureau, Portland Cement Association, Chicago, Ill.

Harry Bruce Walker, extension engineer, Kansas State Agricultural College, Manhattan, Kansas.

Change in Grade

Leonard J. Fletcher, assistant professor of agricultural engineering, acting head of division, University of California, Davis, Calif.

New Members of the Society

Members

Charles J. Allen, second vice-president, S. L. Allen & Co., Inc., Morristown, N. J.

Hubert Avery Hatfield, specialist in tractors and power implements, Box 104, St. Henry, Montreal, Canada.

Joseph Mader, experimental and designing tractor engineer, S. L. Allen & Co., Philadelphia, Pa.

John H. Merrel, general manager, Manhattan Rubber Mfg. Co., Chicago, Illinois.

A. S. Krotz, chief engineer implement division, Samson Tractor Company, Janesville, Wisconsin.

Clarence J. Whitacre, chief engineer tractor and truck division, Samson Tractor Company, Janesville, Wisconsin.

Wilbur L. Powers, chief in soils, Oregon Experiment Station, Corvallis, Oregon.
David Beecroft, directing editor, Class Journal Company, New York City.
George T. O'Maley, proprietor and owner, G. T. O'Maley Ford Sales and Service, Kansas City, Mo.

Associate Members

John Benton Runnels, district manager of power and light department, Western Electric Company, Inc., Kansas City, Mo.
Harold David Lewis, instructor in agricultural engineering, North Carolina State College, Raleigh, N. C.
Charles A. Francis, tractor roadman, Ford Motor Company, Pittsburgh, Pa.

Junior Members

Arthur L. Kline, salesman and agricultural service man, Hercules Powder Company, Wausau, Wisconsin.

Student Branch Members

Floyd H. Crane, Ohio State University, Columbus, Ohio.
C. E. Hall, A. & M. College of Texas, College Station, Texas.
G. E. Ellison, A. & M. College of Texas, College Station, Texas.
Horace Manchester Almy, University of Nebraska, Lincoln, Nebraska.
J. C. Dykes, A. & M. College of Texas, College Station, Texas.
J. Stoll, A. & M. College of Texas, College Station, Texas.
E. Hobbs, A. & M. College of Texas, College Station, Texas.
W. F. Penfound, University of Ohio, Columbus, Ohio.
Arthur Wm. Ferrall, University of Nebraska, Lincoln, Nebraska.
Wm. J. Godtel, University of Nebraska, Lincoln, Nebraska.
Evan A. Hartman, University of Nebraska, Lincoln, Nebraska.
G. F. Harris, Texas A. & M. College, College Station, Texas.
W. S. Mitchell, Ohio State University, Columbus, Ohio.
Chas. J. Movotny, University of Nebraska, Lincoln, Neb.
L. A. Pierce, A. & M. College of Texas, College Station, Texas.
G. E. Martin, A. & M. College of Texas, College Station, Texas.
D. L. Baugh, A. & M. College of Texas, College Station, Texas.
George E. Read, University of Nebraska, Lincoln, Neb.
James Franklin Stoner, University of Nebraska, Lincoln, Neb.
Raymond Arthur Wanek, University of Nebraska, Lincoln, Neb.
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H. L. Alsmayer, A. & M. College of Texas, College Station, Texas.
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E. H. Yarnell, A. & M. College of Texas, College Station, Texas.
E. C. Tuerpe, A. & M. College of Texas, College Station, Texas.